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Cannibalism in Britain: Taphonomy of the Creswellian (Pleistocene) faunal and human remains from Gough's Cave (Somerset, England)

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Synopsis. Human induced damage is the main taphonomic modification observed on the fossil bone assemblage of Gough's cave. Fossils from this site are very fragmentary, showing abundant cut-marks, percussion marks and peeling. Some specimens, however, are complete (ribs, vertebrae, carpal-tarsal bones and phalanges), but these elements are characterised by low marrow content where breakage to open the bone is not needed. Human remains recovered from this site show similar butchering patterns to other animals suggesting skinning, dismembering, defleshing and marrow extraction activities. Excavations during the 1986–1987 seasons showed that the human remains appear at the site randomly mixed with animal bones, with no specific distribution or arrangement of human bones. The evidence from this distribution indicates equal treatment of human and animal remains, and the analysis of cut-marks and other modifications suggests that both humans and animals were accumulated as the discarded food remains of the human population. This is interpreted as nutritional cannibalism. One exception to this is seen in the slight differences in skull treatment compared with other sites, suggesting a possible element of ritual cannibalism (cf Fontbrégoua, the French Neolithic site, ca 4000 BC).

INTRODUCTION

Human remains from Gough's cave (Cheddar) have been recovered during several excavation seasons. They were found together with abundant remains of other vertebrate animals and stone tools from Oxygen Isotope Stage 2 deposits, and most come from the Late Pleistocene interstadial, 11,500–13,000 radiocarbon years ago (Stringer 2000).

The early excavations during the late 1920's and early 1950's took place over a wide area of the cave, and although abundant fossil remains were recovered, no record was kept of the bone distributions. A joint excavation undertaken by the University of Lancaster and The Natural History Museum (UL-NHM) was much more restricted in extent, with most of the bones coming from about one cubic metre of fine gravel and silt between a large rock and the north wall of the cave during 1986–92 (Stringer 2000). These were excavated, however, with much greater precision, and records of the fossils and stratigraphy were kept in meticulous detail, so that more information is available from this small area than for the whole of the previous, much more extensive, excavations. In addition, fossils recovered by this recent excavation have been found to refit with remains recovered by the earlier, indicating that it is the same fossil bone assemblage. The UL-NHM seasons have been essential in interpreting the site formation and the type of cannibalism practised by *Homo sapiens* about 12,000 years ago.

Cannibalism among humans has been a *taboo* topic and is still today a controversial aspect of human behaviour. By definition, a cannibal is a person or animal that eats any type of tissue of another individual of its own kind. Permissive tolerance of human cannibalism has traditionally occurred when referred to 'primitive' societies, but critical reviews such as Arens, (1979) have been sceptical of cannibalism claims based on written references or oral tradition. Taphonomic studies of bone remains of the victims have been the only way to validate some claims for cannibalism (Villa *et al*., 1986a, 1986b; White, 1992; Turner and Turner, 1999; Fernández-Jalvo *et al*. 1999; Degusta, 1999, Defleur *et al*. 1999). The oldest case confirmed as cannibalistic practice among humans was described at the early Pleistocene site of Gran Dolina (TD6, Atapuerca, Burgos, Spain), but a recent study has discovered cut-marks on a right zygomaticomaxillary specimen from the Plio-Pleistocene site of Sterkfontein (South Africa) that may suggest an earliest case of human damage on human remains (Travis *et al*, in press). According to these authors, cut-marks appear on areas of ligament and muscle insertions, suggesting cuts were made on purpose to cut meat. Surprisingly this is the only specimen showing butchering marks, absent on the remaining 763 macro-mammalian fossil specimens, including the rest of the hominid remains recovered from the site.

Cut-marks are of great significance in coming to an understanding of prehistoric human behaviour, but on their own they cannot be used as direct evidence of cannibalism. Cut-marks may appear on human skeletons as result of mortuary rituals, practices still current today, where human carcasses are defleshed but meat or marrow is not consumed. Cuts may be frequent on these skeletons, although cannibalism is absent. Sometimes carcasses are defleshed and meat or organs eaten as result of rituals in relation to beliefs or religion. The identification of nutritional cannibalism, in contrast to ritual, is based on a combination of indicators, the main criterion of which is the comparison of human and animal remains from the same archaeological context. If a human population was living by hunting, and it did not distinguish between animal and human prey, the processing marks left on the bones of both human and animal should be the same. Turner (1983) has given several criteria for recognising nutritional cannibalism, but the most basic criteria by Villa *et al.* (1986a, pg 431) are as follows:

1. Similar butchering techniques in human and animal remains. Frequency, location and type of verified cut-marks and chop-marks on human and animal bones must be similar, allowing for anatomical differences between humans and animals.
2. Similar patterns of long bone breakage that might facilitate marrow extraction.
3. Identical patterns of post-processing discard of human and animal remains.
4. Evidence of cooking; if present, such evidence should indicate comparable treatment of humans and animal remains.

Previous work on Gough's cave material has come to contradictory conclusions. Cook (1986) attributed cut-marks on human remains to natural damage produced by trampling, with the exception of an adult mandible (Gough's cave 6) that shows evidence for deliberate human activity related to post mortem removal of the tongue. Apart from this human fossil, Cook found equivocal cut-marks on animal bones from the site that indicates dismembering activities. Cook, therefore, concluded that cannibalism was absent at Gough's cave. In contrast to this, Currant, Jacobi and Stringer (1989) consider that there is no doubt about human processing of parts of the body at or close to the time of death based on the new material from the 1987 collections. Similarly, Charles (1998) suggests cannibalism was the key factor based on the intermixing of human with animal bones in the deposits.

It is our intention here to show the results of a taphonomic analysis of Gough's Cave fossil remains. Both human and animal bones will be treated equally so that their modifications can be compared with a view to seeing if the agents responsible for the animal bones are the same as those responsible for the human bones. We will focus particularly on the evidence of cut-marks, which are present on both, to see if there is any difference in distribution and/or type of cut-marks. In addition, we will examine features of bone fracture and bone distribution that may contribute to the hypothesis of human cannibalism at the site.

METHODS AND MATERIAL

The fossil material here analysed consists of 240 human and other animal fossil bone fragments. These are in the collection of the Natural History Museum in London. In addition, there are a number of fossil bones at the local museum in Cheddar Gorge that we have not had the opportunity of studying and have therefore not been included. Both human and animal fossil bones have been examined with the aid of a binocular microscope. Some specimens were analysed using scanning electron microscopy (SEM), an ISI ABT55 SEM-fitted with an environmental chamber, operating in the back-scattered electron emission mode at 20 kV, which is housed at The Natural History Museum (London). This type of microscope enables specimens to be directly analysed with no necessity for coating (Taylor, 1986).

Breakage has been analysed following the method of Villa and Mahieu (1991):

1. Number of fractures.
2. Fracture angle: oblique/right/mixed (oblique and right).
3. Fracture outline: transverse/curved-V-shaped/intermediate/ longitudinal.
4. Fracture edge: smooth/jagged.
5. Shaft circumference: 1, circumference is <½ of the original; 2, circumference is > ½of the original; 3, complete
6. Shaft fragmentation: 1, shafts < ¼ of original length; 2, length between ¼ and ½ of original length; 3, length between ½ and ¾ of original length; 4, length >¾ of original length (complete).

Unfortunately, most remains from the study collection had been glued together and traits of fracture angle, fracture outline and fracture edge could not always be identified and quantified. Other fracture traits such as peeling (White, 1992), percussion pits (Blumenschine & Selvagio, 1988), adhering flakes (White, 1992) and conchoidal percussion scars (Blumenschine 1988) were recorded as present or absent.

Bone surface modifications attributed to human action were identified as tool-induced modifications such as incisions, scrape marks, chop-marks, hammer/anvil striations. Emplacement of cut-marks and identification of the muscles or tendons affected by the cuts were recorded. Post-depositional surface modifications were identified as weathering, desquamation, trampling marks, polishing, rounding, gnawing or tooth marks. Post-burial modifications recorded were manganese oxide stains, concretion (cemented sediment heavily attached to the fossil), soil corrosion or root-marks.

Tooth marks were described and measured separately for all anatomical items following Andrews and Fernández-Jalvo (1997):

a. Carnivore pits on bone surface (minimum dimension)
b. Carnivore gnawing on bone surface (transverse measurement of grooves)
c. Carnivore pits on articular surfaces.
d. Carnivore punctures on spiral breaks
e. Carnivore punctures on transverse breaks
f. Carnivore punctures on split shafts
g. Multiple molar pits made by multi-cuspid teeth.
h. Carnivore punctures on intact bone edges

RESULTS

The results of the taphonomic analysis are displayed in Table 1. The main taphonomic modifications that affect these fossils is human activity as seen at this table.

Species represented

The Gough's cave human material consists of both crania and postcrania. The former indicate the presence of five individuals, two adults, two adolescents and one child (Stringer 2000). The adults are represented by a calotte, part of a second calotte and two maxillae and two mandibles. The adolescents are represented by a cranium, two maxillae and one mandible, again suggesting two individuals. The child has a single calvaria. Depending on how the adolescent material is associated, there is a minimum of five individuals in the Gough's Cave deposits (Stringer 2000, Humphrey & Stringer 2002).

The taxonomic identification of the non-human collection analysed here has been done by A.Currant, R.M.Jacobi and C.Stringer. The species found are *Equus ferus*, *Cervus elephas*, *Bos primigenius*, *Sus scrofa*, *Lepus timidus*. The most abundant species represented in the study collection are the equids (Table 1), with 132 specimens, and this compares with 88 human and 42 cervids. Only two bone fragments of bovid, an astragalus and a tarsal, have been recovered from the study collection, and one fragment each of rabbit (tibia) and suid (mandible) species. The latter species have some impact marks, but they are too few to come to any conclusions about their nature and origin, and so our analyses here will concentrate on the modifications of the three common groups, one of which of course are the humans.

Table 1 Summary of taphonomic modifications seen on the fossil bones from Gough's Cave. Modifications are shown for each major postcranial element, which are listed in column 1. The total number of specimens (N) for each element is in column 2, and in column 3 the distribution of modifications by human action is shown for four taxonomic categories: human (**h**), equid (**e**), cervid (**c**) and indeterminate large mammal (**m**). The same distribution is shown for six types of modifications in the remainder of the table as explained in the text.

Anatomical element	Total N	N				Cut-marks				Percussion marks				Concoidal scars				Adhered flakes				Removed flakes				Peeling			
		h	e	c	m	h	e	c	m	h	e	c	m	h	e	c	m	h	e	c	m	h	e	c	m	h	e	c	m
Cranial	4	2	0	2		2	0	0		2	0	0		0	0	0		0	0	0		2	0	0		2	0	0	
Hemi-maxillae	9	2	3	4		2	2	2		2	2	2		0	0	0		0	1	0		0	0	0		0	1	0	
Hemi-mandible	27	6	12	9		2	3	2		0	9	4		0	0	0		0	0	1		0	0	0		1	3	1	
Hyoid	1	0	1	0		0	1	0		0	1	0		0	0	0		0	0	0		0	0	0		0	0	0	
Clavicle	3	3	0	0		3	0	0		0	0	0		0	0	0		0	0	0		0	0	0		1	0	0	
Humeri	6	6	0	0		4	0	0		3	0	0		1	0	0		1	0	0		1	0	0		0	0	0	
Radii	6	5	1	0		1	1	0		3	1	0		0	0	0		0	0	0		0	1	0		1	0	0	
Ulnae	5	4	1	0		2	1	0		1	1	0		0	0	0		1	0	0		0	0	0		2	0	0	
Scapulae	4	4	0	0		4	0	0		1	0	0		0	0	0		0	0	0		0	0	0		2	0	0	
Ribs	45	40			5	20			5	8			3	0			0	0			0	0	0	0	0	8			0
Vertebrae	19	7	7	5		3	6	2		1	1	0		0	0	0		0	0	0		0	0	0		2	0	0	
Pelves	2	0	2	0		0	2	0		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
Femurs	1	1	0	0		0	0	0		1	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
Fibula	1	1	0	0		1	0	0		0	0	0		0	0	0		1	0	0		0	0	0		0	0	0	
Tibiae	8	1	3	4		0	2	3		1	1	1		0	1	0		0	0	0		0	0	1		1	0	0	
Long bones	3	2	0	1		1	0	1		1	0	0		0	0	0		0	0	1		0	0	0		0	0	0	
Patellae	1	0	1	0		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
Carpo-tarsal	35	0	28	7		0	12	3		0	1	0		0	0	0		0	1	0		0	0	0		0	0	0	
Metapodial	35	5	24	6		0	12	6		1	19	2		0	4	0		0	0	0		0	1	1		1	0	0	
Phalanges	54	6	49	4		0	29	2		0	27	2		0	0	0		0	0	0		0	0	0		0	0	0	
Totals	269	90	132	42	5	45	71	21	5	25	63	11	3	1	5	0	0	3	2	2	0	3	2	2	0	21	4	1	0

Skeletal elements

Anatomical elements of humans and other large mammals (horses and deer) recorded at the site suggest some differences between element representation. In general terms, human skeletons are better represented than are those of any of the other large mammals. Human skeletons show a relatively high abundance of cranial remains, ribs, scapulae, and arms (Table 1). In contrast, vertebrae are notable for their near absence, despite the abundance of ribs that were found in association (although not articulation) at the site. There is also a peculiar absence of pelves, carpo-tarsal bones and phalanges which are relatively abundant among horses or deer. Similarly, cranial elements, especially mandibles, are also abundant for both horses and deer, but while metapodials and phalanges are abundant, most limb bones are poorly represented. Horses have an extraordinarily high abundance of phalanges, which are not generally common in human occupation sites. Skeletal element proportions are summarized in Table 2.

Anatomical elements: limb bones

Five upper limb bones from Gough's cave have moderately complete shafts, three clavicles, one humerus and two radii and ulnae. These were recovered in a fragmentary state but reconstructed in the laboratory. For example ulna M54066 is made up by six fragments that make up most of the right ulna (Churchill 2001) and it has a possible antimere in M54067. Two of the clavicles are antimeres, and the four scapulae have been interpreted as representing two males and one female individuals. All have cut-marks, sometimes extensive. The lower limb bones are similarly fragmentary, with no complete bones. There are four left femora, although only one was

Table 2 Skeletal proportions of the anatomical elements recorded for 6 humans, 10 equids and 6 cervids from Gough's cave. Skeletal elements are shown on the left, and percentage occurrences of elements based on numbers present (N_a) divided by numbers of that element present in the skeleton (N_t) multiplied by the MNI.

	Human			Equid			Cervid		
		N_a	N_t		N_a	N_t		N_a	N_t
skull	50%	3	1	0%	0	1	33%	2	1
hemi-maxilla	17%	2	2	15%	3	2	33%	4	2
hemi-mandible	50%	6	2	60%	12	2	75%	9	2
hyoid	0%	0	1	10%	1	1	0%	0	1
clavicle	25%	3	2	0%	0	0	0%	0	0
humerus	50%	6	2	0%	0	2	0%	0	2
radius	42%	5	2	5%	1	2	0%	0	2
ulna	33%	4	2	5%	1	2	0%	0	2
scapula	33%	4	2	0%	0	2	0%	0	2
rib	28%	40	24	0%	0	36	3%	5	26
vertebra	7%	10	25	2%	7	32	3%	5	28
pelvis	0%	0	2	10%	2	2	0%	0	2
femur	42%	5	2	0%	0	2	0%	0	2
fibula	8%	1	2	0%	0	2	0%	0	2
tibia	75%	9	2	15%	3	2	33%	4	2
patella	0%	0	2	5%	1	2	0%	0	2
carpo-tarsal	0%	0	28	11%	28	26	5%	7	22
metapodial	4%	5	20	60%	24	4	25%	6	4
phalange	0%	1	56	41%	49	12	3%	4	24
long bones		2			0			1	
Total number	8%	90	179	10%	132	134	6%	47	128
MNI	6			10			6		

seen, so that at least four individuals are indicated. All four left femora are dyaphysis fragments that represent small individuals, and in addition there is a right proximal femur and fragments of diaphysis from a larger sized individual (Trinkaus 2000), so that the MNI indicated by the femur is five. Nine tibia fragments indicate four individuals, two large and two small (Trinkaus 2000), but only one was seen.

Humerus: There are six fragments of humeri, all of them from a single human individual. The shafts are split longitudinally (shaft circumference category 1, shaft fragmentation categories 1 and 2 according to Villa and Mahieu 1991). The ends are absent, with only one split fragment of shaft near the neck of the head (GC'87, no.12). Cut-marks appear on four of the six fragments of humerus (67%). Cuts run obliquely along the shaft clustered or isolated covering rugose surfaces or muscle attachments (*deltoid* crest, *triceps* insertion or *brachialis* muscle). One of the specimens (GC'87, no.12) preserves the area near the head, and it is here where a cut runs transversally across the humerus on the attachment of *teres minor*. Distally in the same fragment there are also scraping marks near the fracture edge. The scraping marks probably resulted from the removal of soft tissues that could have absorbed the blow when breaking the bone to extract the marrow (Binford, 1981). Three of these cut-marked fragments of humerus also show percussion marks along the broken edges. Some of these fragments also have conchoidal scars, adhered flakes and/or removed flakes, also located on the broken edge. Only one fragment of humerus has weathering in stage 1 (Behrensmeyer, 1978) and two are affected by trampling, but none of them have tooth marks.

Summary of humeri. Total 6 specimens, all human.
Cut-marks: 4 specimens (2 on fossils from the 1987 collections)
Percussion marks: 3 specimens (2 on fossils from the 1987 collections)
Conchoidal scars: 1 specimen (1 on fossils from the 1987 collections)
Adhered flake: 1 specimen
Removed flake: 1 specimen

Ulna: There are five fragments of ulna, four of them from humans (2 rights, 2 lefts, 2MNI) and one from a horse. The human fragments of ulna consist of longitudinal splits, as seen on the humeri, but several fragments have been refitted so that they now form most of the bone circumference (3 of them have circumference category 3 according to the classification of Villa and Mahieu, 1991). Two of the ulnae have cuts on the surface, running obliquely to the length of the

Fig. 1 **A,** Left human ulna GC87-209, midshaft fragment with part of the lateral aspect of the shaft. Cut-marks run obliquely across the posterior ridge (i.e. along the bottom of the shaft), and another concentration occurs more distally (not shown here). There is extensive peeling at the proximal end, on the left as shown here, and three massive percussion impact marks can be seen medially, along the upper edge of the bone as viewed here. There is also an adhered flake on the lateral aspect. **B,** Six fragments making up most of right human ulna M54066 (GC202, 243, 119c). Fractures are mixed, smooth, and fragmentation 3/4. Breakage appears to be natural with no percussion marks and no cut-marks. **C,** Proximal radius and ulna GC89-071&073 of *Equus ferus*. Cut-marks are seen on the olecranon process. **A,** × 1.6; **B,** × 0.5; **C,** × 0.7.

bone and probably related to the insertion of the *flexor* muscles. Percussion marks and adhered flakes have also been observed on one of these two damaged ulnae (GC'87 209) along the broken edge. Both ulnae show clear evidence of peeling, one on the proximal broken edge (Fig. 1A). The other two fragments of ulna which have not been damaged by human action have been refitted from several small split shafts found several metres apart from each other, in one case all the fragments coming from the 1987 excavation (M54066), and in the other, some fragments coming from the 1987 excavation and refitted with old 1927 excavation fragments (M54067). The proximal end of the right ulna M54066 (Fig. 1B) has lateral crushing of the head. No cut-marks or percussion marks have been distinguished on either of these two ulnae. One ulnae fragment (GC'50 420) is weathered in stage 1 or 2 and has dispersed manganese on its surface.

The only horse ulna-radius (GC'87 73) has only the proximal end preserved (circumference category 3, length category 1, Villa and Mahieu 1991). The heads of both the ulna and the radius are extensively cut and show percussion marks (Fig. 1C) and a flake has been removed from the interosseous space between ulna and radius. Percussion marks are present on the olecranon.

Summary of ulnae. Total 5 specimens, 4 humans, 1 equid
Cut-marks: 3 specimens (2 human, 1 equid) (1on fossils from the 1987 collections)
Percussion marks: 2 specimens (1 human, 1 equid) (1 on fossils from the 1987 collections)
Adhered flakes: 1 specimen (human) (from the 1987 collections)
Removed flakes: 1 specimen (1 equid)
Peeling: 2 specimens (human) (from the 1987 collections)

Radius: There are five fragments of all of them humans. There are two with proximal articulations with complete circumference, category 2 and 3 (Villa and Mahieu, 1991) and more than the half of the length of the bone. Specimens M54071 and GC'87 74 are refitted shafts (5 and 7 respectively) of split shaft fragments, open longitudinally and mostly category 1 shaft circumference. Only one of these radii has cut-marks (Fig. 2A). These cuts were formerly interpreted as decorative engraving. They appear on the lateral surface along the length of the bone, bordering the origin of the *flexor pollicis longus*, but there is no muscle attachment along this part of the shaft (between the ulna and the radius). On the SEM we could observe that each group of incisions is actually a single compound mark made by a single stroke (Fig. 2B). Directionality is the same in every set (Fig. 2B), and it appears to be the result of filleting, removal of the muscle progressively along the shaft. With regard to breakage, two of the radii have percussion marks, which are distributed along the longitudinal broken edge. One of the radii also shows large percussion marks on the anterior and posterior edges. Peeling is seen on M54071 on at least three joint fragments. This specimen has many percussion impacts mainly along broken edges, and there are at least two large impact scars along the anterior side and one impact pit on the posterior surface.

Summary of radii. Total 6 specimens, 5 human, 1 equid
Cut-marks: 2 specimens (1 human, 1 equid) (1 from the 1987 collections)
Percussion marks: 4 specimens (3 human, 1 equid)

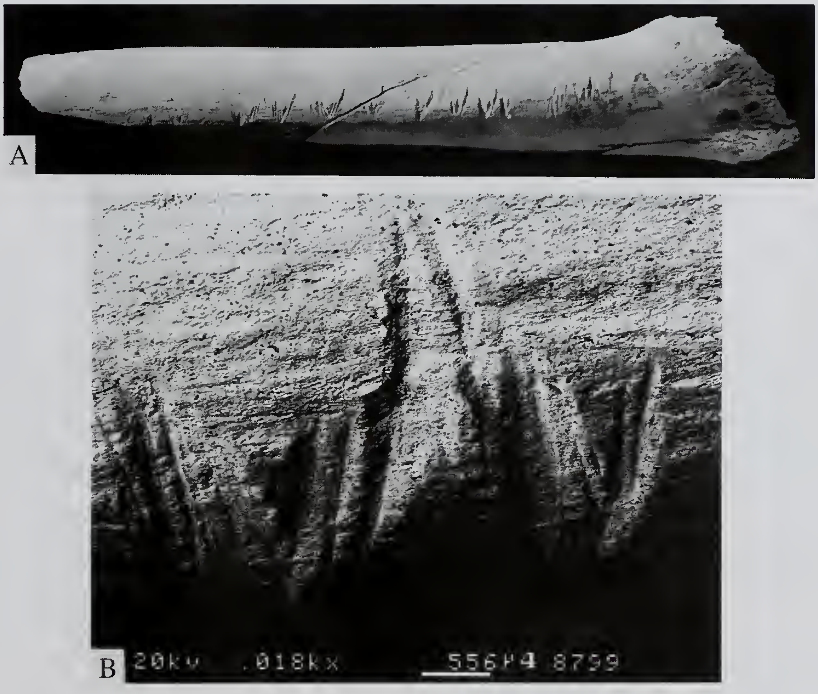

Fig. 2 **A,** Right human radius GC87-74. Partial diaphysis with the anterior surface preserved for most of it length. Extensive cutmarks are present on the lateral surface, which is the side of the shaft away from the ulna where there are no muscle attachments, but in addition there are a few cut-marks proximally (on the left as seen here) on the supinator insertion. These marks have been interpreted as engraving, but all of the 'groups' of incisions are actually compound marks made by single strokes, with consistent directionality towards the superior aspect of the shaft. This is interpreted as filleting of the arm muscles progressively along the shaft. **B,** Scanning electron micrograph of GC87-74 cut-marks. Notice that marks are made by the same stone tool edge and made with a sawing motion that follows the same direction for all cuts along the bone shaft. **A,** × 1.1.

Fig. 3 **A,** Distal articulation of tibia M50017, left distal tibia of Rangifer tarandus. This articulates with astragalus M49914, and both have matching cut-marks, probably for disarticulation of the foot. **B,** Distal tibia, no number, of *Equus ferus*, with cut-marks on the distal turberosity and oblique break, circumference 3, of the shaft. **C,** Right distal tibia of *Equus ferus*, GC87-4. The distal articular surface is intact. The shaft is broken with oblique fracture, circumference 3. There are cut-marks on the lateral ridge of the distal tubersosity and carnivore chewing just proximal to the cut-marks, but they do not overlap and so their relative times of occurrence are unknown. There are extensive percussion marks on all surfaces of the shaft in the region of the oblique break, with a conchoidal scar posteriorly (on the right side of the break as viewed here). Finally, there is a network of shallow rootmarks on the shaft. **A,** × 1; **B,** × 0.65; **C,** × 0.6.

Removed flakes: 1 specimen (1 equid)
Peeling: 1 specimen (1 human)

Femur: We only saw one fragment of human femur, although five individuals are apparently represented in the collection (Trinkaus 2000). The femur fragment we saw is a split fragment of shaft (no ends, circumference category 1, length category 1, Villa and Mahieu, 1991) with strongly developed linea aspera. It does not have cut-marks but it has percussion marks. These percussion marks are along the linea aspera, 3 grouped together.

Fibula: There is only one fragment, which has been identified as human. It is part of the shaft having a circumference category 2 and length category 2 (Villa and Mahieu 1991). It has cuts near the end of attachment of the *soleus* muscle indicating dismembering activities, and evidence of breakage provided by an adhered flake depressed into the cavity.

Tibia: There are nine human tibia fragments, but we only saw one fragment, plus three of equid and four of cervid. One of the cervid tibiae has tooth marks on the surface. They are chewing marks on anatomical edges (tooth marks type c following to Andrews and Fernandez-Jalvo, 1997) measuring 1.4 and 0.9 mm (average 1.15mm). The human tibia fragment is a longitudinally split section of shaft with no ends (circumference category 1 and length category 1). In contrast to this all animal tibiae have circumferences category 3 and length between 1 and 2 (according to Villa and Mahieu, 1991). It is apparent from this that the animal bones are preserved differently from the human long bones. There are no cut-marks on the human tibia fragment, but percussion marks are present. On the animal bones, cuts appear on 5 of the 7 distal ends of tibiae. The cuts are related to the articulation of the tibia with the tarsals, on the distal ends (Fig. 3A), or on the posterior and/or anterior surfaces (Fig. 3B), and all are related to dismembering the ankle joint. The distal end of another equid tibia with a small part of the shaft shows cuts on the lateral maleolus, probably also related to cutting the short and long lateral ligaments when dismembering the foot. Another distal end with a small part of the shaft of cervid also has cuts on the shaft, but this time they appear on the opposite side of the shaft from percussion marks (see below).

With regard to fracture, the human tibia has peeling on one of the ends and percussion impact scars on the edge of the longitudinal breakage. This suggests there were several impacts on the bone to open the bone longitudinally and expose the marrow. One of the equid tibiae (GC'87-4, Fig. 3C) has a conchoidal scar on the posterior midshaft and extensive percussion marks all round the shaft. Two of the four cervid tibiae show percussion marks. One of them (M50019) has percussion marks on the opposite side of cuts, which suggests that the latter could be anvil marks as result of blows on the bone. The other (M50017) has a flake removed on the lateral side near the broken edge and a percussion impact mark on the plantar side, near the articulation (Fig. 3A). M50017 has also trampling marks running transversally.

Summary of tibiae. Total 8 specimens 1 human, 3 equid, 4 cervid
Cut-marks: 5 specimens (2 equid, 3 cervid) (1 each of cervid and equid from the 1987 collections)
Percussion marks: 3 specimens (1 human, 1 equid from the 1987 collections)
Conchoidal scars: 1 specimen (equid from the 1987 collections)
Removed flakes: 1 specimen (cervid)
Peeling: 1 specimen (human from the 1987 collections)

Long bones (indet.): There are three fragments of long bones two of them identified as humans and the third as cervid, though the anatomical elements could not be specified. One of the human split shafts has oblique cuts and percussion marks on the edge of the fracture. The cervid shaft is formed by two longitudinally split fragments, having several cuts running transversally along the edge, and an adhered flake between the joint fracture of both fragments.

Anatomical elements: hands and feet

Calcaneus: There are eight calcanei, seven of them are from equids and only one of cervid. Cut-marks are present on five specimens (4 equids and 1 cervid):
4 on the lateral side of the calcaneus along the plantar and the dorsal surfaces (4 equids)
2 on the upper edge of the calcis (2 equids)
1 on the medial side distally and on upper surface (equid)
1 on the dorsal side close to the articulation with the astragalus (1 cervid)

Cuts are related to plantar ligament and lateral and medial ligaments, with the cutting directed at dismembering the ankle joint.

Four calcanei are chewed, three of them very heavily (Fig. 4A). Puncture marks are superimposed over cut-marks and percussion marks on one of these calcanei (M50029), which indicates that carnivore activity occurred after human. Chewing marks are pits on the surface (type a, average 2.0mm, N = 6), grooves on surface (type b, average 1.6mm, N = 7) and only one of type c (1.5 mm) and one of type h (3mm).

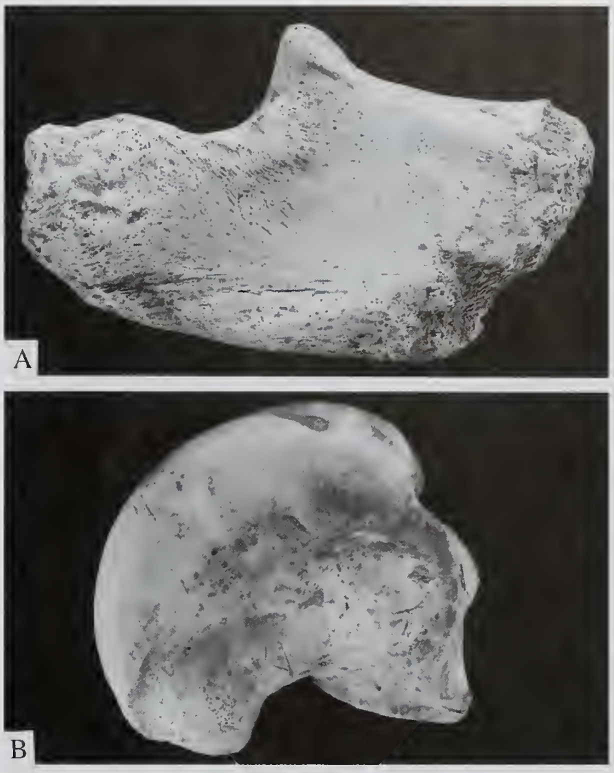

Fig. 4 **A,** Left calcaneus M50029 of *Equus ferus*. Much of the calcis has been damaged by extensive percussion marks on both sides, and there is a cluster of cut-marks along the upper edge just posterior to he articular surface. **B,** Medial view of left astragalus of *Equus ferus*, M49843. Cut-marks are present in three clusters, one on the medial edge of the medial condyle, the second on the medial surface of the body, both seen here, and the third on the upper edge of the lateral condyle. Both figures, × 0.9.

Summary of calcanei. Total 8 specimens, 7 equid, 1 cervid
Cut-marks: 5 specimens (4 equids, 1 cervids).
Percussion: 1 specimen (1 equid)

Astragalus: there are ten specimens of equid astragali (left 5, right 5, MNI 5) and five cervid astragali. Nearly all specimens are complete. Cut-marks are present on five of the equid astragali and two of the cervid astragali:
5 astragali have cuts on the medial condyle, medial side (3 equids and 2 cervids)
4 astragali have cuts on the medial surface of the body, and on the proximal and/or distal tuberosities (2 equids, 2 cervids)
2 astragali have cuts on the central trochlear ridge (1 equid, 1 cervid)
1 equid astragalus has cuts on the lateral condyle, medial side
2 astragali have cuts on the lateral side of the lateral condyle (1 equid, 1 cervid)
1 equid astragalus has cuts on the posterior surface of the body.

Cut-marks are most abundant at the medial condyle and medial surface of the body (Fig. 4B). The medial surface bears on its distal part a large tuberosity and on its proximal part a smaller one for the

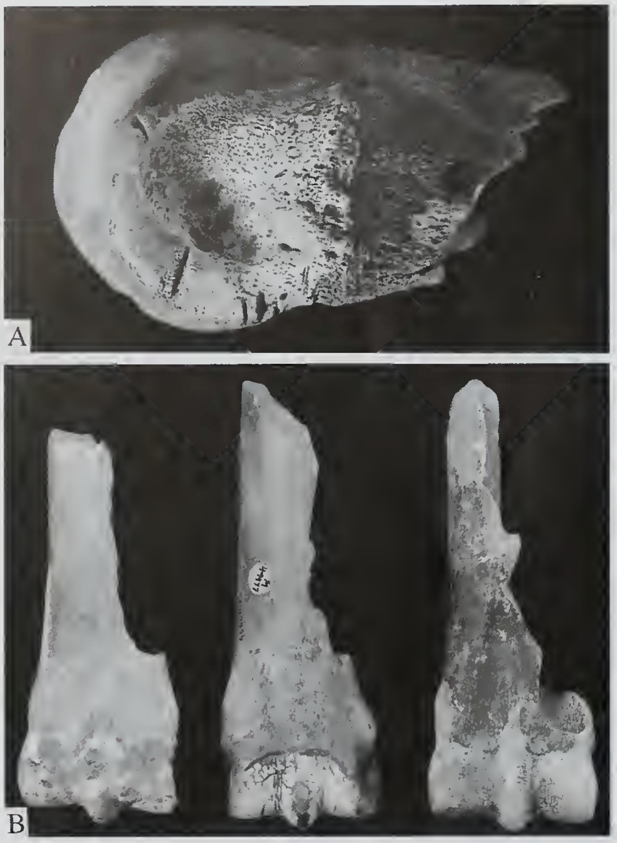

Fig. 5 **A,** Distal metapodial of *Equus ferus*, M50043. Deeply incised cut-marks can be seen around the edge of the articular surface. **B,** Three distal metapodials of *Equus ferus*, from left to right ventral view of M49834, dorsal views of M49977 & 49950. In each case, the shaft is split up to the articular surface with oblique fractures, curved, smooth, and shaft circumference 2. On M49834 there are cut-marks on the terminal end of the central ridge of the trochlea and a conchoidal scar on the dorsal side of the oblique fracture (not seen here); M49977 has percussion marks on the central ridge of the trochlea, visible here on the dorsal aspect as discolouration of the articular surface, conchoidal scars along the oblique break, and cut-marks on the shaft; M49950 also has cut-marks on the shaft along the ridge bordering the post-articular sulcus and conchoidal scars along the oblique break, and there are extensive percussion marks on the distal (terminal) part of the articular surface. These modifications appear to be concerned with breakage of the shaft for extraction of marrow and disarticulation of the foot. **A,** × 0.7; **B,** × 0.4.

attachment of the medial ligament of the hock joint. Cuts are therefore aimed at disarticulating the tarsal bones and tibia. Most of the marks were distributed in clusters of short incisions but no chops or percussion marks have been recorded. The lateral surface is smaller and has a wide rough fossa in which the lateral ligament is attached, and only isolated incisions have been found on the lateral trochlea. No human activity has been observed on these bones, so that there is no evidence of percussion or conchoidal scars. There is also no evidence of peeling, flakes removed or adhered flakes.

Carnivore chewing marks are present on two specimens, one of them heavily chewed (M50003, lacking cut-marks). The chewing marks are mainly on the articulation with the calcaneus (type b, average 1.9mm, N = 2 and type c, average 2.8mm, N = 14)

Summary of astragali. Total 15 specimens, 10 equid, 5 cervid
Cut-marks: 7 specimens (5 equid, 2 cervid).

Third tarsals: Seven specimens of equid tarsals have been seen, all complete. Cut-marks are present only on two specimens, transverse incisions across the dorsal surface. Three of the tarsals are slightly cracked by weathering, and two have manganese stains.

Other podials: There are a magnum and a scaphoid of equid, two naviculars (1 equid, 1 cervid) and a central tarsal of horse, all of them complete. Human-induced damage is evident on the scaphoid that has cut-marks on the dorsal surface, and on the central tarsal that bears an adhered flake on a lateral broken surface on the articular dorsal ridge. All of them are slightly cracked on surface.

Metapodials: There are five human metatarsals, twenty four metapodials of equids and six of cervids. They have mostly come from the earlier excavations, with only three of the human metapodials coming from the 1987 excavations.

Human metapodials are mainly shafts, sometimes with one end. They have no cut-marks on their surface or articulations. Animal metapodials are all distal ends, except for 13 lateral metapodials of equid that are complete. All human and equid lateral metapodials have length category 3 (almost complete). Medial metapodials have circumference almost complete with the exception of three of them that have circumference 2, but they have length values that are mostly category 1 (less than 1/4th of the length) or category 2 (less than half of the original length) (Villa and Mahieu 1991). Cut-marks are present on 18 of the 30 animal metapodials (6 cervids, 12 equids), but they have been found on none of the humans. Cuts are located on the trochlea, all round the articulation (Fig. 5A) or on the dorsal/ventral surfaces close to the articulation. Medial metapodials of horse have a consistent pattern of breakage (Fig. 5B) indicated by breakage on the shaft close to the distal articular end and extensive percussion marks providing similar bone fragments.

Human metatarsals are all crushed on one or both ends. The ends show evidence of chewing marks, peeling or percussion marks on the edge of the articulation. Two human metapodials appear chewed (a 5th and a 2nd left), although no actual clear puncture mark can be measured. The 2nd left human metatarsal shows strong similarities with a suid rib experimentally chewed by humans (Fig. 6). In contrast to this, no carnivore tooth marks have been recorded on any other animal metapodial surface.

With regard to lateral metapodials of equids, they show similar crushing on articular ends to that seen in humans. Lateral horse metapodials have a consistent pattern with percussion marks on proximal ends on the outer (lateral) surfaces and only rarely on the inner articular surface with the medial metapodial (only 1 specimen). Percussion marks appear on one specimen distally as well. Sometimes, percussions are associated with chop marks (2 cases) and/or cut-marks (3 cases) transversally to the length of the bone. Percussion marks are located on the lateral tuberosity of the proximal end. One of the bones has three chewing marks, type b averaging 1.4mm, N = 3.

The length of metapodials is variable, but none has been split longitudinally. Percussion marks on 21 of the metapodials, however, are located at one side (ventral or dorsal) or distributed on lateral, ventral and dorsal surfaces or, more exceptionally on the articulation. A distal metapodial of cervid has a percussion triangular shape as observed in mandibles (see below). Some metapodials have been seen to have scratches on the opposite side of percussion marks, probably as result of anvil effect on the bone during breakage. Four metapodials show conchoidal scars and flakes removed on the broken edge.

Fig. 6 **A,** a suid metapodial; and **B,** a second left human metatarsal, GC87-30. The suid metapodial was experimentally chewed by humans. The extensive fracturing of the proximal ends, with depressed flakes of bone and splaying of the ends, is extremely similar in both bones, and may indicate human chewing on the metatarsal from Gough's Cave; × 1.2.

Only three metapodials have trampling marks and five have evidence of wet abrasion. One metapodial is weathered in stage 3 or 4 and two are in stage 1 or 2. Manganese oxide stains affects 10 of the 35 metapodials.

Summary of metapodials. Total 35 specimens, 5 human, 24 equid, 6 cervid
Cut-marks: 18 specimens (12 equids, 6 cervids).
Percussion: 22 specimens (1 human from the 1987 collection, 19 equids (11 lateral metapodials), 2 cervids)
Conchoidal scars: 4 specimens (4 equids)
Flakes removed: 2 specimens (1 equid, 1 cervid)
Peeling: 1 specimen (1 human)

Phalanges: There are 22 proximal phalanges, one human, 20 horse and one cervid. The only human phalanx here studied is from the hand and it has the proximal end smashed and the distal end intact. This is similar to patterns observed in the human collection of Atapuerca, Mancos and the Anasazi pueblos (Andrews & Fernandez-Jalvo 1997).

Most horse proximal phalanges are intact except for M49945, which has the proximal end removed by heavy percussion impacts. A flake has been removed on the medial edge, and the shaft is cracked both longitudinally and transversely with percussion marks on the broken edge. Another horse phalanx (M49788) is complete, but shows very heavy percussion marks on ventral (palmar) surface: two multiple marks on the distal articular surface (Fig. 7B) and two extensive percussion marks on the proximal articular end. In general, percussion marks may occur on the lateral, dorsal or ventral surfaces, as well as proximal and distal ends. Cut-marks are oblique to the length of the shaft on both dorsal and especially on ventral surfaces (Fig. 7A). Carnivore chewing appear on two phalanges (M 49787) showing four carnivore pits on the surface (type a, average 1.7mm, N = 4), grooves on the surface (type b, average 1.4mm, N = 14), and eight carnivore pits on articular surfaces (type c, average 1.65mm, N = 8). The average width of carnivore gnawing grooves that affect the proximal phalanx M49958 is 0.72mm. Manganese staining affects eight proximal horse phalanges on the surface. There is no evidence of water damage observed on other phalanges from this study collection. The only proximal cervid phalanx is longitudinally broken with grooves and percussion marks on both sides of the fracture. Cuts affect the phalanx on the dorsal surface and on the articulation.

There are 13 middle phalanges, 11 of horse and two of cervid. Fewer cut-marks and percussion marks are present on the middle phalanges, and where they occur they tend to be at the end of the bones near the articular surfaces. Two of the horse phalanges show percussion marks, but both of them are complete. One of them (M49921) has extensive percussion all around the dorsal (proximally on articular surface) and lateral surfaces. The horse phalanx labelled as number 23 from the excavations of 1987 shows also extensive percussion marks on the dorsal surface. Cut-marks are abundant and very marked on M50030 (Figs 7B, 7C) affecting dorsal and ventral surfaces on the shafts, proximal and distal ends and articular surfaces. Manganese stains cover all over the surface of three medial horse phalanges. Both second phalanges of cervid are complete. Phalanx M49758 shows deep cuts on the ventral side on the shaft and a couple of small incisions on the lateral side of the articulation (distal end).

There are 18 terminal phalanges of horse and one of cervid. Eleven of the horse phalanges have percussion marks and cut-marks on the flexor surface, hoof surface and dorsal surface (Fig. 8). Six of horse and the cervid phalanges have no modifications. Cuts on the ventral side affect the deep flexor tendon, although this would seem to be an uncommon area of cutting related to dismemberment of the hoof. Two horse phalanges (M49959, M49879) show water damage.

Summary of phalanges. Total 54 specimens, 1 human, 49 equid, 4 cervid
Cut-marks: 31 specimens (29 equid,. 2 cervid)
Percussion marks: 29 specimens (27 equid, 2 cervid)

Anatomical elements: axial skeleton

Ribs: The human ribs from Gough's Cave are attributed to three individuals (Churchill 2000). The first individual has lightly constructed ribs and must have been relatively small. The associations between ribs are based on size, curvature and morphology of the iliocostal line, which is superoinferiorly compressed in this individual (Churchill 2000). The heads of all but one rib are missing from this individual, perhaps because it represents an immature individual. The ribs of the second individual are more robust, with heavier muscle markings, and again the heads are missing from all but one rib. The ribs from these two individuals were found in partial association during the 1986–1987 excavation, in close proximity although not articulated (Fig. 9, data from 1987 excavation). A third individual is represented by six fragments forming parts of three ribs from the left side, and a further ten fragments that could not be further identified are also present (Churchill 2000). The 40 human ribs contrast with only five of large mammal. Individual two is the more complete, with 18 ribs, 6 of them complete. Individual one has 16 ribs, 6 of them complete. Human induced damage on the ribs is very extensive (Table 3), with 30 of the 45 total number of ribs (animal and human) showing human-induced damage. Of the

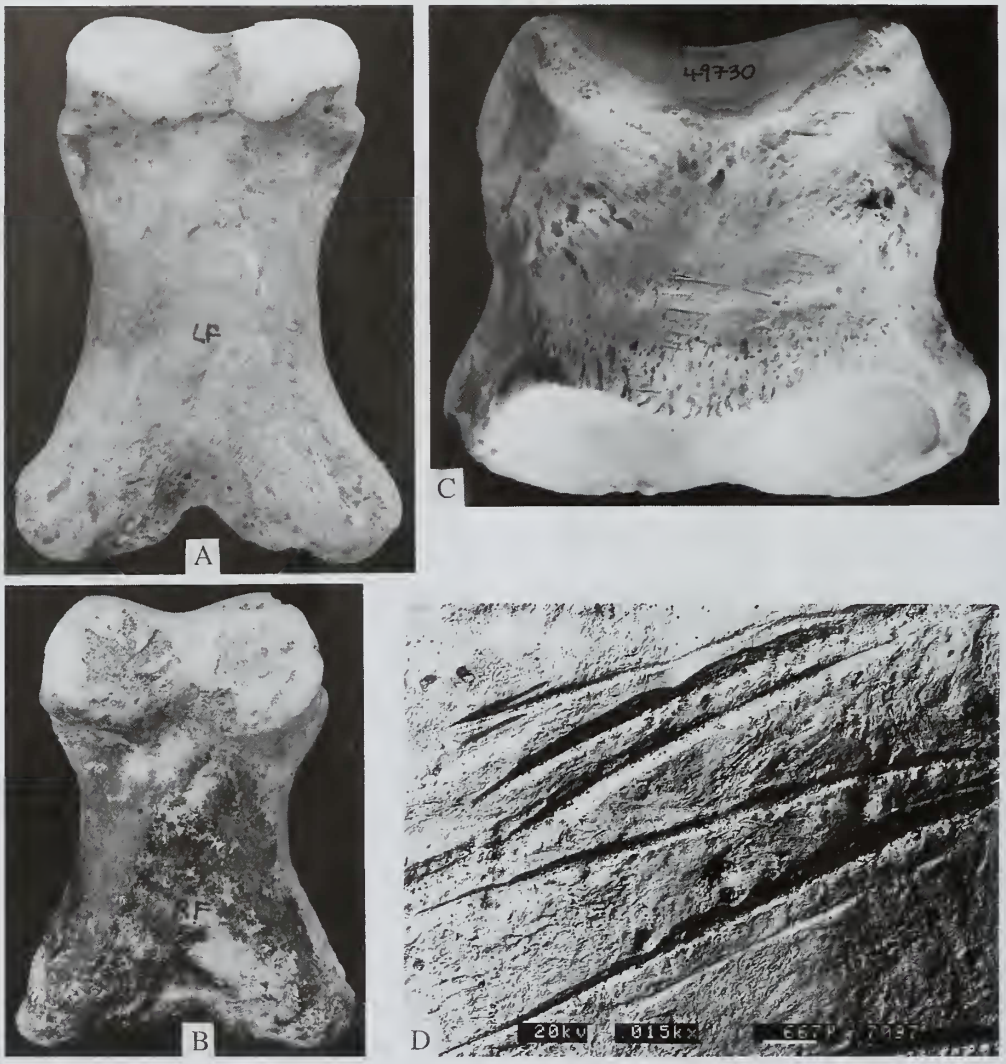

Fig. 7 **A,** First phalanx of *Equus ferus* M49730. Two areas of cut-marks are present, both on the ventral surface, one laterally and the other proximally. **B,** First phalanx of *Equus ferus* M49788. Very heavy percussion marks are present on the ventral (palmar) surface of the distal articulation, seen as two rosette-shaped multiple marks with a single additional mark laterally, and at the proximal end there are two extensive areas of percussion damage ventrally, on either side of the proximal articular surface and extending round on to this surface. **C,** Middle phalanx of *Equus ferus*, M50030. A series of distinct cut-marks cross the dorsal surface on the shaft and the medial edge of the distal articular surface. **D,** SEM micrographs of a set of stone tool cut-marks of a second phalanx of equid (M49999). These marks are related to meat filleting. The cut-marks are characterised by V-shaped sections, microstriations running linearly along the length of the cut, lateral and more superficial cut ('shoulder effect' Shipman and Rose 1981) and irregular displaced bone on the side of the striations caused by resistance of the bone to the cut friction ('herzinian cones' Bromage and Boyde, 1984). **A,** × 0.9; **B,** × 0.85; **C,** × 1.3.

unmarked ribs, only 2 of the 15 are complete. Cut-marks are present on 25 of the ribs and occur on the shafts as well as both caudal and sternal ends. Extensive peeling is seen on the human ribs, sometimes on both ends of the fragment and sometimes also on the shaft at the inferior border or broken edges. Percussion marks are frequent on most of the ribs (Fig. 10B).

There is one case of percussion damage on associated human ribs that suggest that this activity took place when the ribs were still anatomically joined together. There are two percussion/chop marks that coincide between the inferior border of rib 5 and the superior border of rib 6 of individual 2 (Fig. 10 B). In addition there is a massive chop mark on the superior border of rib 5 coinciding with a percussion mark on the inferior border of rib 4 from the same individual. Rib 4 also has extensive peeling all along the inferior border on the outer surface (Fig. 11). The inner surfaces of the ribs are affected by cut-marks on 5 human ribs from both individual 1 and 2, and similar marks are seen on a large mammal rib that also bears percussion marks. In any case, the outer surface of the ribs is the most affected area by intensive cutting, percussion and peeling.

Cut-marks on ribs are mainly oblique to the long axis of the bone, but also longitudinal and sometimes transverse around the head of the ribs on both animal (Fig. 12A) and human ribs (Fig. 12B). Scratches related to anvil-hammerstone effect have also been observed on at least two ribs. Fig. 13 shows the actual number of cut-marks found on all human ribs from Gough's Cave.

Tooth marks are recorded on only two human ribs, but they could

Table 3 Human induced modifications observed on ribs and clavicles. The ribs are identified to individual 1 or 2, their number and left or right. Modifications are shown according to their position on the bones (internal surface, outer surface, caudal end, mid-haft, sternal end, and inferior or superior borders). Modifications are identified as c = cutmark; p = peeling; perc = percussion/chop marks. Sequences of modifications are given in order of importance.

Register number: RIBS	Identity	Side	Internal surface	Outer surface	Caudal	Shaft	Sternum	Inferior	Superior
M54016	human; ind.2	1st L		c		c			
M54017	human; ind.2	2nd L		p/c		p/c		p	c
M54018	human; ind.2	3rd L		p	p				
M54019	human; ind.2	4th		c/p/perc		p/perc	c	perc/p	c
M54020	human; ind.2	5th L		perc		perc		perc	perc
M54021	human; ind.2	7th L		(chop)/c/p	c/perc/p	perc(chop)		perc	
M54022	human; ind.2	6th L (2/3 rib)		perc/c	c	perc(chop)	c		perc(chop)
M54023	human; ind.2	8th-9th L (head rib)		c	c			c	
M54024	human; ind.2	8th-9th L (body frag)		c		c			
M54025	human; ind.2	8th-9th L (body frag)							
M54026	human; ind.2	2nd R (1/2 body)							
M54027	human; ind.2	3rd R		perc		perc			
M54028	human; ind.2	4th R		c/p/perc		perc	c/p		chop
M54029	human; ind.2	5th R		c/perc	perc		c	perc	
M54030	human; ind.2	6th R (part body)		c		c			c
M54031	human; ind.2	7th-9th R (head of rib)	c		c				
M54032	human; ind.2	10th R (part body)							
M54001	human; ind.1	1st L		c	c			c	c
M54002	human; ind.1	2nd L (caudal end)							
M54003	human; ind.1	3rd L (caudal end)		p		p		p	
M54004	human; ind.1	4th L							
M54005	human; ind.1	5th L		c			c		
M54006	human; ind.1	6th L							
M54007	human; ind.1	7th-9th L (frag blade)		c/perc		c			perc
M54008	human; ind.1	12th L		p					
M54009	human; ind.1	2nd R	c		c			c	
M54010	human; ind.1	4th R	c			c			
M54011	human; ind.1	5th R							
M54012	human; ind.1	6th R (caudal end)	c	c	c			c	c
M54013	human; ind.1	7th-9th R (shaft)							
M54014	human; ind.1	11th R	c	c	c		c	c	c
M54015	human; ind.1	12th R (part blade)		c/p		c/p		p	c
M54033	human								
M54034	human			c			c	c	c
M54035	human								
M54036	human								
M54038	human								
M54040	human								
M54041	human								
M54052	human	2 indet. fragments							
GC'86 28	equid-cervid			c			c		c
GC'86 28	equid-cervid	L		perc/c		perc/c		p	
	equid-cervid			perc/c	perc	c			
GC'89 3	equid-cervid		perc/c	c	perc/c			p	
GC'90 184	equid-cervid			c					
CLAVICLES									
M54053	human	L	c	c	c	c	c	c	c
M54054	human	R		c/p	p		c	scraping	
M54055	human	R	c	c	c			c	c

not be measured. It is possible that these chewing marks could be human in origin (1 human rib). Carnivore chewing has also been recorded on one deer rib, type a average 1.9, N = 6, and type b average 1.3, N = 5. Trampling marks have been seen on 4 human ribs. Six ribs are weathered, but only to stage 1. One of the human ribs is affected by weathering on the outer side but the inner side looks fresh. Manganese oxide stains are present on one large mammal rib, and one human rib has root-marks on its surface.

Summary of ribs. Total 45 specimens, 40 human, 5 large mammal

Cut-marks: 25 specimens (20 humans, 5 large mammals)
Percussion: 11 specimens (8 humans, 3 large mammals)
Peeling: 8 specimens (8 humans)

Clavicles: There are three specimens of human clavicle, two of them almost complete (Fig. 14). They have cut-marks on both the inner and outer surfaces, caudal, shaft and sternum surfaces, and on both the inferior and superior edges (Table 3). There are no percussion marks, anvil-hammerstone scratches, conchoidal or flakes that may suggest breakage of this anatomical element, though peeling is

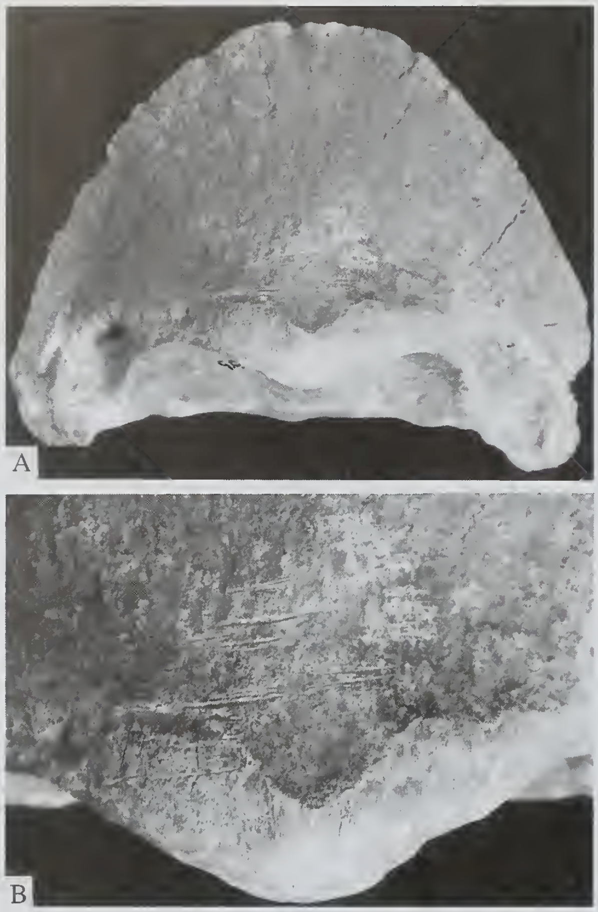

Fig. 8 Two views of distal phalanges of *Equus ferus*. **A**, dorsal view, with transverse cut-marks across the body and dorsal edge of the proximal articulation; **B**, an enlarged view of these cut-marks. **A**, × 1.1; **B**, × 2.2.

present in one of the clavicles (M54054) on the caudal outer surface indicating bending of the bone to dismember or detach the clavicle. Scraping also occurs on this clavicle.

Vertebrae: There are ten human vertebrae in the Gough's Cave material. Most of these were cervical vertebrae, but there were four fragments of thoracic vertebrae, three neural arches and part of one body. It is possible that nine of the vertebrae could be from a single individual (Churchill 2000), and since they were found with the two partial sets of ribs it is likely that they came from one of these individuals. We were able to study seven of the vertebrae (1 axis, 3 cervicals and 3 thoracics), seven of equid (1 atlas, 1 axis, 4 cervicals and sacrum). There are five cervid vertebrae (3 cervicals, 1 thoracic and the 1st caudal). Most vertebrae are affected by human induced damage (Fig. 15), with only two human and two cervid vertebrae that are intact and undamaged. Neural arches are broken in two of the human vertebrae. The vertebral bodies from humans, equids and cervids have cut-marks or percussion marks, especially on the anterior part of the body. The human axis (M54042, Fig. 16A) has cuts on the anterior side of the body along the insertion of the *stylohyoid* muscle (Fig. 16B). Most transverse processes on human, equid, and cervid vertebrae are broken or cut on the posterior part of the vertebra. One human vertebra shows peeling on the transverse processes. The laminae of the vertebrae, especially those of equids, but also of humans and cervids, are also broken (peeled apart in humans) or cut on one side or all round the spinous process.

Tooth marks are abundant on the vertebrae, with five specimens showing chewing or tooth marks, but only a few of these were clear enough to be measured on the equid sacrum. The type of tooth marks are pits on bone surface (a, average 2mm, N = 2), grooves on bone surfaces (b, average 1.6 mm, N = 4), and tooth print (g, 2.9 + 2.9, total length 7.9 mm). Trampling marks have been seen on two cervid vertebrae and manganese oxide stains on three vertebrae of equid.

Summary of vertebrae. Total 19 specimens, 7 human, 7 equid, 5 cervid
Cut-marks: 11 specimens (3 human, 6 equid, 2 cervid)
Percussion: 2 specimens (1 human, 1 equid)
Peeling: 2 specimens (2 human)
Tooth marks: 5 specimens (4 equid, 1 cervid chew mark)

Anatomical elements: flat bones

Pelvis: Two equid pelves are the only specimens found of this element. One specimen has the ileum and part of the acetabulum preserved, the other is almost complete with the pubis recently broken. Cut-marks (Fig. 17) are concentrated along the spine and along the posterior edge on the dorsal side of the ileum, as well as on the ridge below the acetabulum, and chop marks are present on the spine near the acetabulum. The most complete pelvis has cut-marks on similar areas but also including the ischium on both sides (dorsal and ventral). Trampling occurs extensively on one of the pelves, and manganese oxide stains occur on both. Both pelves also have carnivore damage, mainly on the ischium and ventral side of the ileum proximal edge. Types of tooth marks are as follows (Andrews & Fernandez-Jalvo 1997): a (pit marks on bone surface) average 1.5 mm, N = 5; b (grooves on bone surface) average 1.5 mm, N = 4; c (punctures on anatomical borders) average 3.5 mm, N = 2.

Summary of Pelves. Total 2 equid specimens
Cut-marks: 2 specimens

Scapula: The scapula is also poorly represented in the collection, with just four fragments from humans. Cut-marks and scraping marks are extensive on all four scapula fragments. The scapula M54057 which was partially recovered in 1927 has been completed by refitting fragments recovered in 1987. The cuts are mixed on most scapulae with trampling marks (Fig. 18A). Some incisions are definitively human made because they bend without interruptions and pass over and around curvatures in the bone. They are present on both dorsal and ventral sides. Cuts also occur over areas protected by the curvature of the bone (eg. between acromium and the scapula neck; Fig. 18B). In these positions, trampling is impossible because they are deeply recessed, and further the marks are deeply incised, which is not usual in trampling marks (Andrews & Cook 1985). Cuts show a random distribution by direction related to the strong muscle attachments. Scrapes occur on the deeply concave angle between the spine and the infraspinatous fossa. Peeling occurs laterally on two specimens (M54057 and M54059) and the latter also has percussion marks on the spine, probably as result of dismembering processes of the humerus from the scapula. Only one scapula (M54057) shows evidence of weathering which is located along the infraglenoid tubercles along the lateral margin, indicating the scapula was resting with the spine down in the soil.

Summary of scapulae. Total 4 specimens all human
Cut-marks: 4 specimens
Percussion: 1 specimen
Peeling: 2 specimens

Fig. 9 The Gough's Cave excavation showing some of the human ribs in individual 2 being excavated beneath the overhang of the side wall.

Anatomical elements: Cranial

Mandibles: There are three adult human mandibles in the collection, counted as six hemi-mandibles, 12 specimens of equids, and 9 of cervid. All the mandibles are heavily damaged. The equid mandibles consist either of symphysis (50%) or alveolar fragments (50%) with no inferior border or ascending ramus. Most mandibles have some of the premolars and molars *in situ*. Cervid mandibles show a similarly highly destructive pattern, with broken fragments consisting only of portions of alveolus with no inferior border or ascending ramus. The only exception to this pattern is shown in Fig. 19, where a cervid mandible is shown with a dental series and diastema complete to the symphysis. Most mandibles of cervid (56%), but also some horses (33%), show percussion marks on the lingual side, some of them with massive damage (Fig. 19B). Also common are cut-marks on the buccal side (Fig. 19A). Such strength applied to the mandible has produced severe damage, not only to the mandible, but also to most of the teeth, which are seriously crushed (Fig. 19B). It is further peculiar that three of the cervid mandibles and one of the horse mandibles have a triangular shaped percussion mark (Fig. 19B), also seen on a distal metapodial of cervid (M49832). The triangular percussion mark is quite deep, suggesting a forceful stroke.

Human mandibles are also heavily damaged in a similar way, although they have no percussion marks. A complete human mandible (M54137b) has both ascending rami broken. The right hemi-mandible has extensive peeling on the ascending ramus, possibly related to breakage of the articular condyle, and slight breakage is seen along the inferior border close to the mandibular angle (lower angle of the mandible). The left hemi-mandible has the ascending ramus broken in the region of the temporal muscle insertion. (coronoid process) and the articular condyle. Another hemi-mandible shows deep incisions at the ascending ramus (Fig. 20A) probably inflicted as a result of masseter muscle removal.

A third human mandible (M54130a) shows extensive cuts on the lingual surface of the body (along the *linea mylohyoidea*) and also on the buccal side, and there are percussion marks on the buccal side as well. The left ascending ramus is broken at the articular condyle and the right ascending ramus is missing. The inferior border on both sides of the mandible is broken, and peeling is evident on the left side along the fracture edge. Cuts are also present on the symphysis on the lingual side (*fossa digastrica* and *spina mentalis*) (Fig. 20B). It is remarkable that one horse symphysis also shows cuts on the inner margin of the symphysis (Fig. 20C) similar to that seen on humans. This evidence is reinforced by the recovery of the hyoid of a horse that has percussion marks and is extensively cut.

Trampling is evident on equid and cervid mandibles. Weathering has been detected on three mandibles (two of horses and one of deer) at stage 1 and 2/3 on one of the horses. Manganese covers four of the deer and horse mandibles, with the three deer mandibles are heavily stained.

Summary of hemi-mandibles. Total 27 specimens: 6 human, 12 equid, 9 cervid
Cut-marks: 6 specimens (4 human, 3 equid, 2 cervid)
Percussion: 13 specimens (9 equid, 4 cervid)
Adhered flakes: 1 specimen (1 cervid)
Peeling: 5 specimens (1 human, 3equid, 1 cervid)

Fig. 10 **A,** Three human ribs from individual 2, numbering from the top ribs 4, 5 & 6. The inferior border of rib 4 (M54019) has several percussion/chop marks, notably one about one third the way from the caudal end; the superior border of rib 5 (M54020) has a chop mark opposite this mark on rib 4, and it has two percussion/chop marks on its inferior border; the superior border of rib 6 (M554022) has a chop mark opposite the first and a percussion pit opposite the second. These are shown in context in Fig. 11. **B,** Rib of *Cervus/Equus* (GC86-28) with head intact and much of the shaft, with extensive cut-marks along the superior border and percussion marks on the inferior border. **A,** × 0.7; **B,** × 0.55.

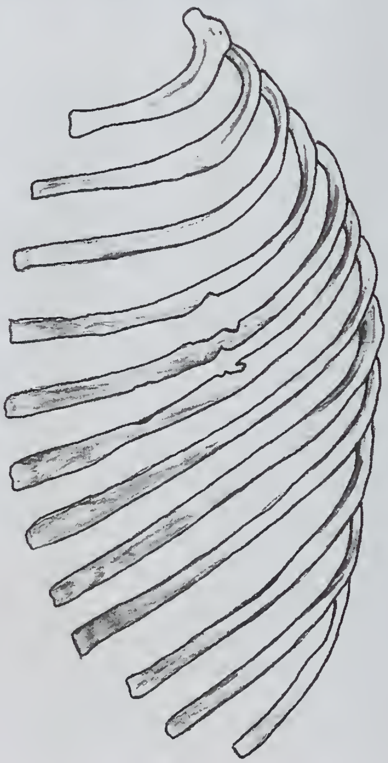

Fig. 11 Drawing of left rib cage with the percussion and chop marks of ribs 4, 5 & 6 shown in the context of the whole rib cage.

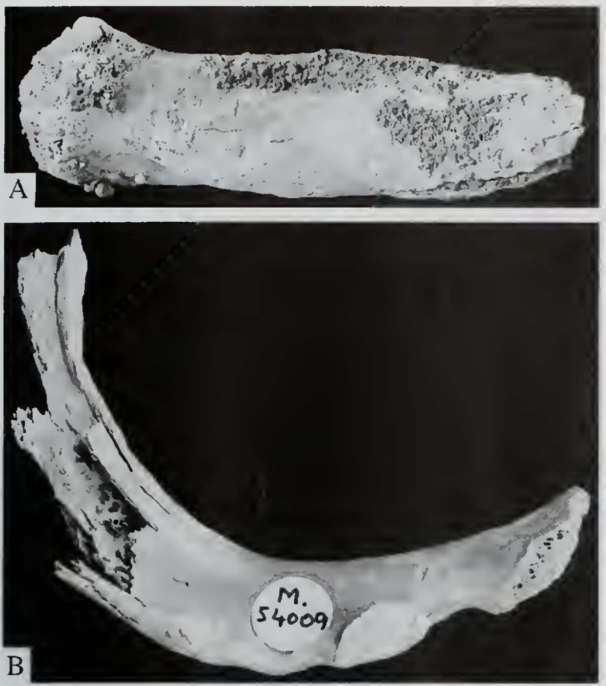

Fig. 12 **A,** Caudal end of *Rangifer tarandus* rib, no number, with cut-marks running transversely across the neck of the rib close to the articular facet of the tubercle. **B,** Caudal end of a human rib, M54009, with both ends broken and cut-marks running transversely across the neck of the rib and into the articular facet of the tubercle. **A,** × 1.3; **B,** × 1.4.

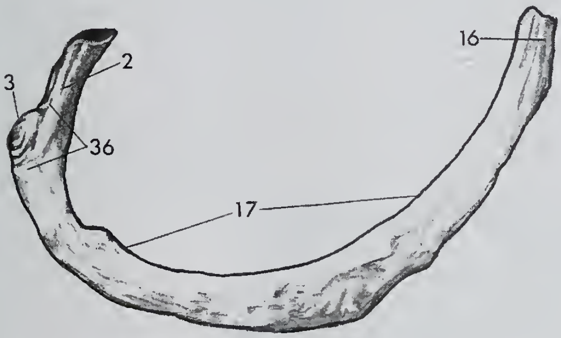

Fig. 13 Generalized view of human rib showing the numbers of cut-marks found on all human ribs from Gough's Cave, and their distribution on the rib.

Fig. 15 **A,** Axis vertebra M54042. Numerous cut-marks are present on this bone, particularly along the anterior surface of the body of the vertebra (i.e. on the front of the body, not the back). The conformation of these cut-marks is shown in Fig. 16. There are also cut-marks superiorly next to the articular surface connecting to the atlas vertebra, and in this region there is also peeling of the bone on the lateral aspects on both sides of the articulations. **B,** Cervical vertebra of *Equus ferus* (M50068) with cut-marks along lateral-ventral surface. Cut-marks are short and concentrated along the anatomical edge probably related to the detachment between vertebrae. **A,** × 1.2; **B,** × 0.65.

Maxillae: There are two human palates, and three half-maxillae of equid and four of cervid. Two human half-maxillae, with both zygomatics broken, are from the same individual (M54130b), and they fit with mandible M54130a described above (Fig. 21A). The muscle insertions of the nose and lips (levator muscles and the zygomatic and masseter muscles) are affected by cut-marks on the human specimen, which also has cut-marks on the front of the palate. Apart from cuts, the nasomaxillary bone is heavily modified around the lips and nose, and this is similar to cut-marks seen on the buccal surfaces of the molars (Figs 22, 23) as it is observed in other cannibalistic sites (Atapuerca in Spain, Fontbrégoua in France and

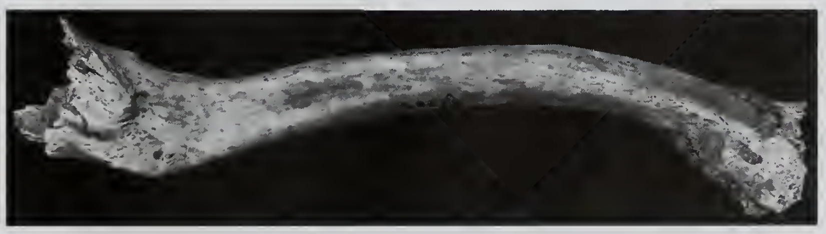

Fig. 14 Right clavicle M54055 diaphysis. Cut-marks are present in two places, two marks on the deltoid insertion and two also where the *cortoclavicular* ligament attaches to the shaft of the clavicle; × 1.

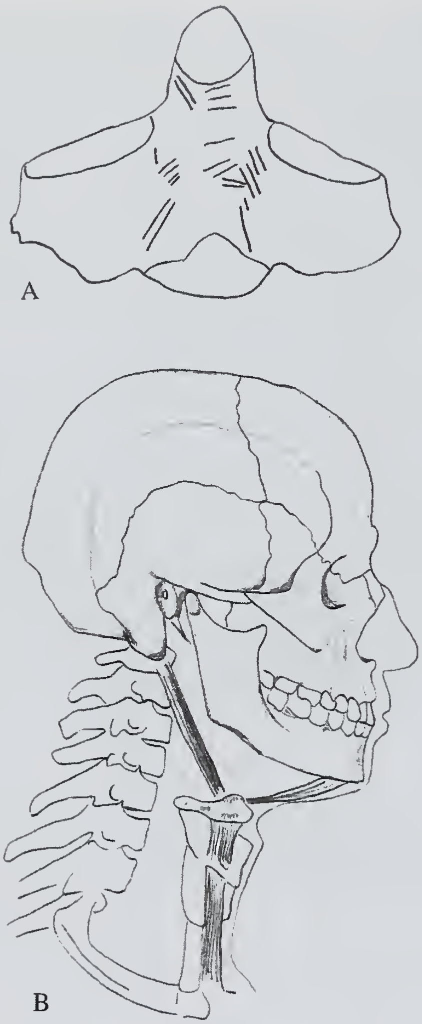

Fig. 16 **A,** Human axis vertebra M54042 showing the conformation of the cut-marks along the anterior surface. This is the area of attachment of the anterior longitudinal ligament, and in addition the superior marks are probably related to the detachment of the axis from the atlas, and the posterior marks to the detachment of the axis from the third cervical vertebra; × 1.2. **B,** Schematic drawing of human skull and upper vertebrae showing the disposition of two muscles that insert on the internal surface of the mandibular symphysis (digastric muscle) and the back of the skull (stylohyoid muscle).

Anasazi pueblos in States). Breakage of the zygomatic arches is necessary in order to remove the *temporalis* muscle so as to open the vault for access to the brain tissues.

Other animal maxillae are heavily broken, with only alveolar fragments and few premolar and molar preserved *in situ*. Horses show percussion marks on buccal and lingual sides, or only on the buccal. Cut-marks have not been seen on the bone of horse maxillae, but there are two specimens that show oblique cuts on the buccal side of the premolar/molar toothrow (Figs 21B, 22). Extensive percussion marks appear on both the lingual and the buccal sides of horse maxillae, and one specimen has adhered flakes also on both sides. It is interesting to note that one horse maxilla has peeling on the palate.

Fig. 17 Innominate of *Equus ferus* M50028. This bone has been extensively modified, with loss of the extremities and many trampling marks on both surfaces. There are many carnivore tooth marks on the upper border of the ilium, and four chop marks are also present crossing the spine near the superior border of the ilium. More inferiorly there are numerous cut-mark incisions concentrated along the spine; × 0.8.

With regard to cervids there are cuts only on the buccal side of the maxilla, along the dental series (Fig. 21C). Percussion marks on the lingual side have only been seen on one cervid specimen. No teeth have cut-marks on cervid maxillae, but the teeth are heavily crushed on the lingual side or broken.

Summary of hemi-maxillae: Total 9 specimens, 2 human, 3 equid, 4 cervid
Cut-marks: 6 specimens (2 human, 2 equid, 2 cervid)
Percussion: 6 specimens (2 human, 3 equid, 1 cervid)
Adhered flakes: 1 specimen (1 equid)
Peeling: 1 specimen (1 equid)

Skull: There are three human calottes (frontal, parietal and most part of the occipital) of an adult, adolescent and child. The adult skull is almost complete, although the face is missing (broken at the orbital region and maxilla), and a frontal fragment. There are two cervid skulls, both broken but there is no conclusive evidence of human damage. One of the cervid skulls shows weathering at a stage 1.

The human calottes show similar patterns to each other regarding cut-marks and percussion marks. Extensive and long cut-marks are present on the temporal insertions of the parietal bones on both sides (Figs 24A, C). Many cuts are also present on the frontal bones (Fig. 25) and on the supraorbital ridges (insertions of the *orbicular* and *superciliary* muscles), as well as in the eye sockets to extract the eyes (Fig. 24B). On the occipital bones, cuts are also seen along the

Fig. 18 **A,** Left scapula with the spine and part of the inferior blade of M54059. There are many trampling marks mixed in with cut-marks, and it is sometimes hard to distinguish them. Numerous scrapes occur in the deeply concave angle between the spine and the infraspinous fossa, with percussion marks on the edge of the inferior border. There are also percussion marks and peeling on the acromion process. The scrape marks are not straight, bending without interruption over and around curves in the bone surface, and they cut across several incisions perpendicular to the general trend of the scrapes, the cut-marks clearly preceding the scrapes. In the angle between the acromion and the scapular neck, cranial orientation, there are two oblique and deep incisions not visible on this view but similar to the ones in M54056. **B,** Right scapula M54056. Two incisions, one deep and the other shallow, are present in the angle between the acromion and the neck of the scapula, and in addition several cut-marks are present in the inferior angle of the scapular blace at the insertion of teres major. **A,** × 0.9; **B,** × 0.65.

sutures with the parietal bones, covering the insertion area of the *trapezius* and *sternocleidomastoid* muscles (Figs 24D, 25B). Percussion marks appear superimposed on cut-marks on the parietal bones at both sides (Fig. 24C) and cuts appear interrupted by the broken edges. Incipient peeling has been seen on the zygomatic arches, and some removed flakes on the broken edges (i.e. left side of the sphenoid bone and occipital bones).

Summary of skulls. Total 5 specimens = 3 human and 2 cervid)
Cut-marks: 2 specimens (2 human)
Percussion: 2 specimens (2 human)
Removed flakes: 2 specimens (2 humans)
Peeling: 2 specimens (2 human)

DISCUSSION

Large mammal species diversity recorded at Gough's cave is quite poor, with most remains assigned to three species of large mammals, *Homo sapiens*, *Equus ferus* and *Rangifer tarandus*.

The human skeletal element proportions are generally higher than those of any of the other large mammals. Ribs and cranial remains are the best represented for humans, but paradoxically, vertebrae are rare, whereas for the animal bones ribs are almost absent but vertebrae and especially phalanges and metapodials are much better rbepresented. Phalanges in particular are not commonly represented in human occupation sites. The relative abundances of anatomical elements suggest a type of selection for large mammal skeletons for heads and distal limbs, in contrast to human skeletons, for which elements from the thorax (except vertebrae), heads and arms have been selected.

The cranial skeleton is the most extensively damaged anatomical element, both in humans and large mammals (equids and cervids). Human skulls and faces at Gough's Cave have a higher intensity of cut-marks than are present on non-human animals, but contrasting with this, two of the human skulls are almost complete. Skull completeness differs greatly from site to site where cannibalism has been considered to be nutritional (i.e. TD6-*Aurora Stratum*, Spain), the Neandertal site of Moula-Guercy (France Defleur, *et al.*, 1999), or modern ones where fire is involved such as Native American sites

Fig. 19 **A,** lingual, and **B,** buccal views of deer mandible (*Rangifer tarandus*), M49821. The buccal view shows numerous cut-marks along the diastema, and the lingual view shows one and possibly two percussion marks near the alveolar border; both × 0.5.

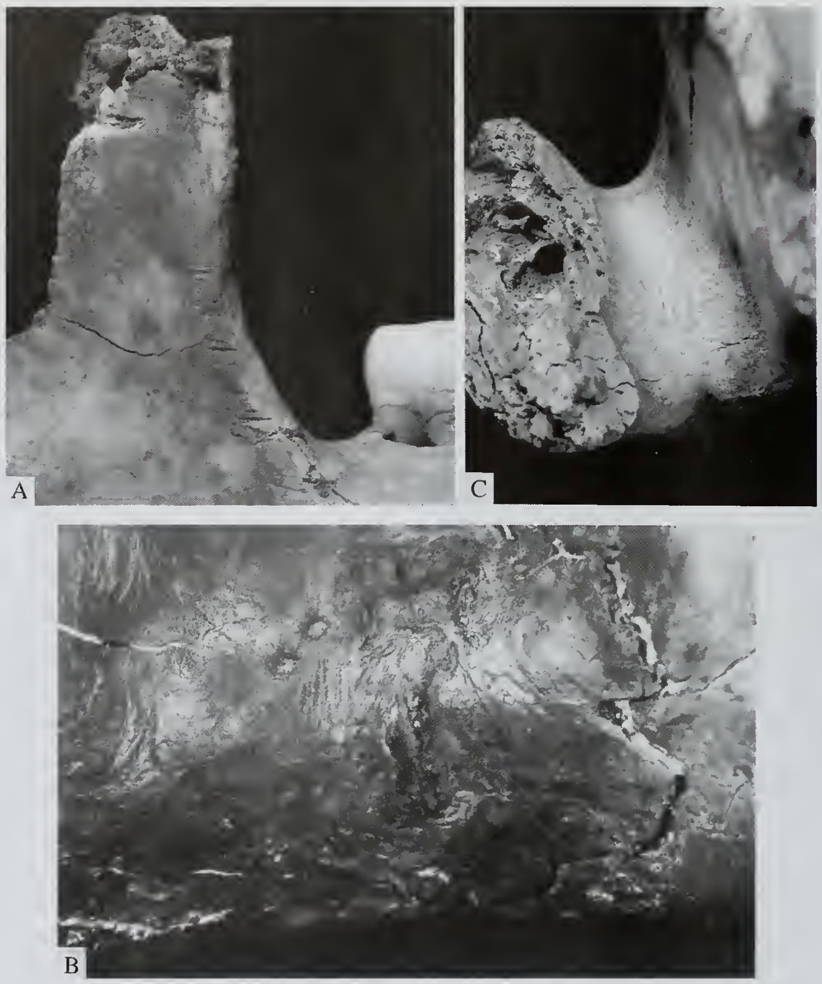

Fig. 20 **A,** Human mandible (GC'87) showing deep incisions on the ascending ramus as a result of dismemberment of the mandible probably inflicted as a result of *masseter* muscle removal. **B,** Detail of cut-marks on human mandible M54130a. The cuts are on the mandibular symphysis on the lingual side along the internal ridge, at the insertion of the *digastric* muscle. **C,** Mandible of *Equus ferus* M49848. Cut-marks are on the mandibular symphysis on the lingual side, and on the lingual border of the mandibular body close to the alveolar margin and on the lingual border of the diastema. **A,** × 2; **B,** × 3; **C,** × 1.2.

(USA, Turner and Turner, 1999; White, 1992), Navatu (Fiji Islands, Degusta, 1999). At all these sites, damage to the human skulls is great and it is interpreted as the result of gaining access to the brain. The only other cannibalistic site where human skulls are relatively complete is at Fontbrégoua (French Neolithic) where Villa *et al.* (1986a&b) interpreted it as an element of skull ritual treatment. We agree with this interpretation in relation to the Gough's Cave material because completeness of skulls, even where they have been damaged by percussion and intensive cutting, is an exception to the general pattern of the Gough's Cave assemblage. Animal skulls are notable for their absence, and most other skeletal elements, with the exception of the limb extremities and some of the human ribs, are all broken. The human skulls stand out as the most intact groups of bones that by their nature are relatively easily broken by post-depositional processes.

The jaws in particular have been heavily broken and cut. Most large mammal jaws recovered from the site consist of alveolar fragments, with or without teeth. Teeth are damaged by crushing, especially in cervids, but also in humans. There is a peculiar butchering technique observed on these specimens consisting of intensive cutting on the buccal side, and strong percussion marks on the lingual side. These suggest dismemberment of the mandible and cutting of the muscles of mastication and the lip depressors. Cut-marks lingually, particularly on the symphysis in the digastric area on both equids and humans, indicate removal of the tongue. Cut-marks have also been found on the enamel of horse upper molars on the buccal side. These cuts have also been observed at other sites such as Abric Romani (~40,000 BP. Barcelona, Spain), and here they have been interpreted as cutting of facial muscle attachments to extract the cheek.

Damage is also seen on human jaws with breakage of zygomatic arches on the upper jaws, and inferior borders and ascending ramii of mandibles. Similar destruction of human remains also appears at Native American sites (White, 1992; Turner and Turner, 1999), Fontbrégoua (Villa *et al*, 1986 a, b) and especially at TD6-*Aurora Stratum* (Fernández-Jalvo *et al.*, 1999), where no complete cranial element (skull vault, mandible or maxilla) has yet been found. Some authors have considered that this degree of intensive damage of faces

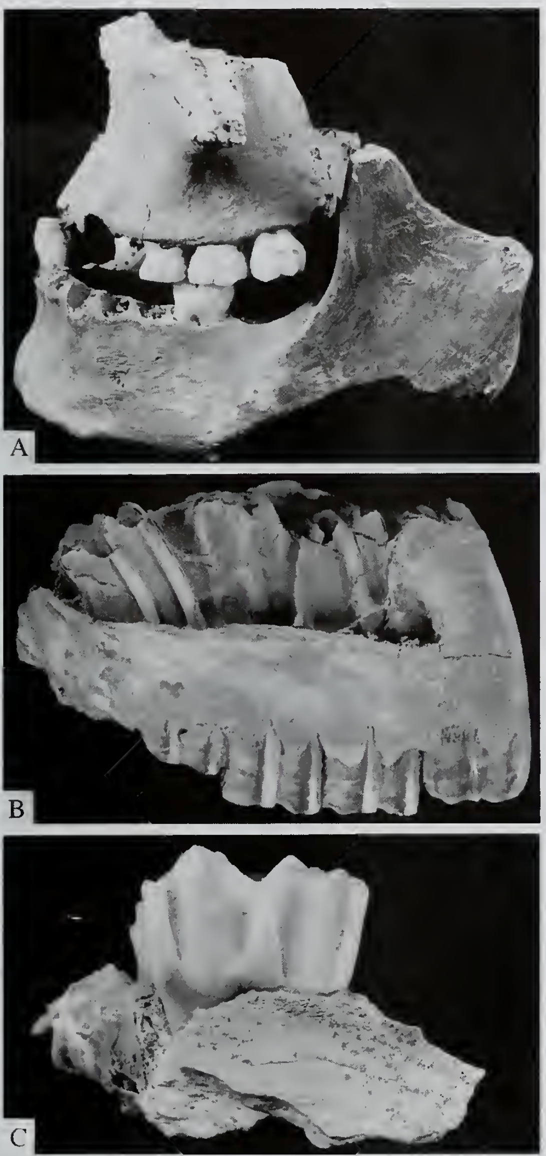

Fig. 21 **A,** Human maxilla (M54130a) and mandible (M54130a) from a young individual. The jaws are heavily damaged by percussion and cutting. The maxilla has both zygomatic arches broken and extensive cuts on the *masseter* insertion, as well as on the face above the canines where the lips attach, and on the palate. Cuts on the mandible are present on both lingual and buccal sides of the mandible. Also in the area of the medial *pterygoid* insertion and coronoid process the inferior border is broken and the ascending ramus broken. **B,** Maxilla of horse *Equus ferus*, GC89-061. The body of the maxilla is broken, with several percussion marks along the broken edge and one on the undamaged surface of the bone. There are also two sets of cut-marks passing diagonally across the buccal sides of the teeth which are shown in the next figure. **C,** Maxilla of red deer M49981, with cut-marks just below the alveolar margin on both the buccal and lingual surfaces. **A,** × ??; **B,** × 0.5; **C,** × 1.2.

and jaws is evidence of violence and destructive intent of mutilation of a possible enemy (Turner and Turner, 1992). In Gough's Cave, large mammal jaws have similar degrees of destruction to human jaws and faces and, we therefore do not consider this evidence as indication of human-to-human violence.

Cook (1986) also rejected any interpretation of violence on the Gough's Cave assemblage. Cook's critical review of the marks recorded on these fossils led her to interpret most marks on the human bones as being due to trampling (Andrews & Cook 1985, Cook 1986). In fact, Cook considered as the only firm evidence of deliberate human interference some marks on the buccal surface and inferior border of the adult mandible (M54130, Gough's 6). Cook (1986) considered these marks as related to removal of the tongue. It is remarkable that one horse mandible has also cuts on the inner inflexion of the symphysis (Fig. 20C), similar to the location on the human jaw (Fig. 20B), and this also suggests extraction of the tongue. Intensive cuts (and percussions) on an equid hyoid could indicate the same thing, as well as cuts on the anterior side of the human axis body (see Fig. 16) where hyoid ligaments attach.

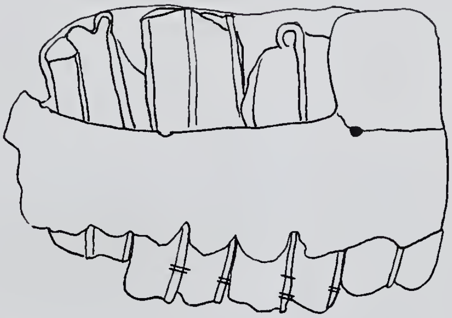

Fig. 22 Drawing of maxilla of horse *Equus ferus*, GC89-061, showing the locations of the two sets of cut-marks running along the buccal side of the crowns of the teeth. The marks appear to be lined up in two series running obliquely down mesially.

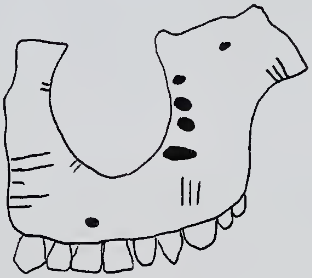

Fig. 23 Oblique frontal view of M54130, juvenile maxilla showing the location of cut-marks on the frontal aspect around the lips and nose and on the zygomatic.

No fragments of equid skulls have been recovered from Gough's Cave. Skull fragments of cervids (a calvaria and a frontal fragment) have no conclusive evidence of human-induced damage. In contrast to this, the two human skulls are heavily damaged by cut-marks and later percussion marks, but despite this, both were recovered almost complete. The adult calvaria was found virtually in one piece, but the

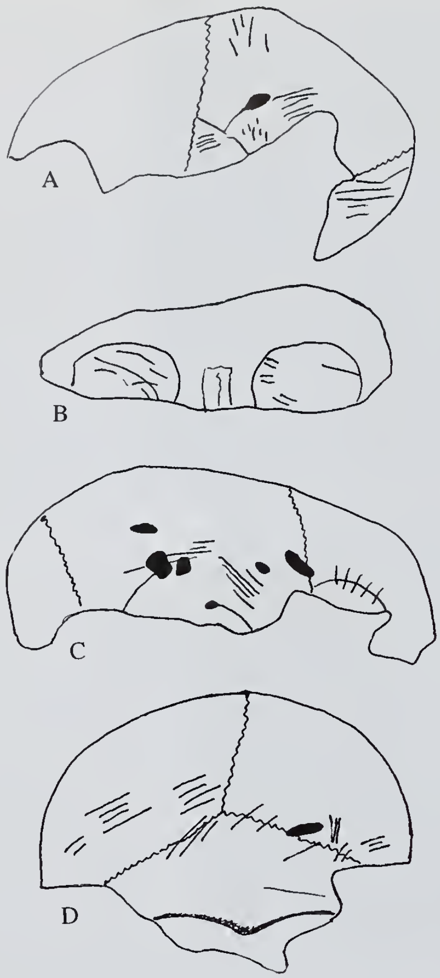

Fig. 24 Four views of human calvaria. **A,** lateral view of child's skull M54141 showing cut-marks and one percussion mark causing extensive cracking of the skull. **B,** frontal view showing cut-marks inside the orbits. **C,** lateral view of skull 460a, showing percusssion marks superimposed on cut-marks along the temporal muscle insertion. **D,** back view of the same skull showing extensive cut-marks in the broken occipital region.

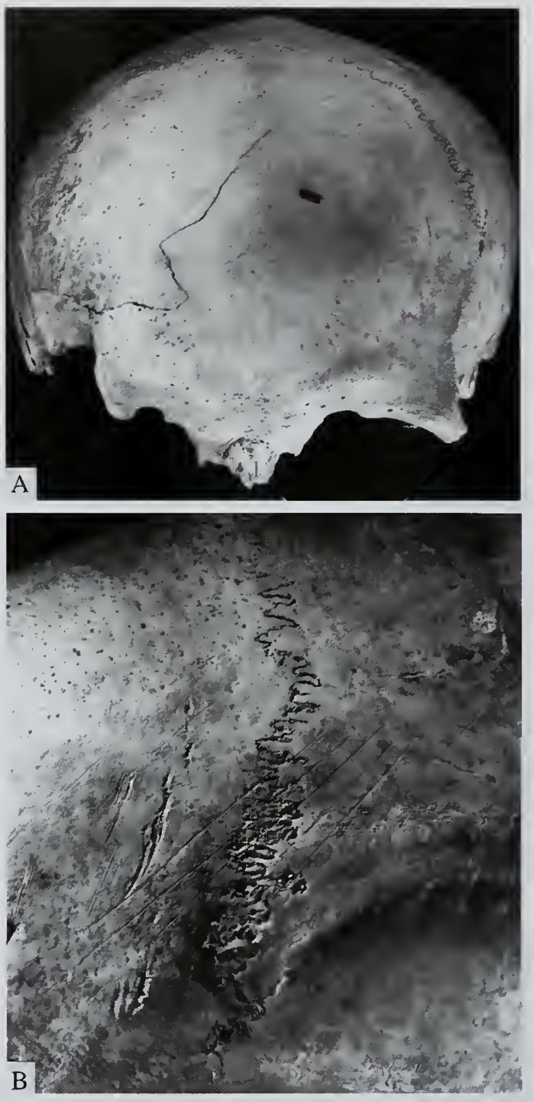

Fig. 25 **A,** Frontal view of the GC87 calotte showing cut-marks low down on the frontal bone. **B,** detail of the parietal (left) and occipital bones of the same calotte showing the cut-marks in this region. **A,** × 0.6; **B,** × 1.1.

child calvaria was fragmented by post-depositional damage, due to the greater fragility of its bones. This is in contrast to traits observed at the site of Atapuerca (TD6-*Aurora Stratum*, Spain) where mandibles and skulls of both humans and non-humans were highly broken, and cuts appeared on areas related to dismembering rather than skinning. In the light of taphonomic analyses of the Atapuerca TD6-*Aurora Stratum* fossil assemblage, the cause of cannibalism was considered to be purely nutritional, and probably gastronomic (Fernández-Jalvo, *et al.*, 1999).

Southwest Native Amerindian sites (White, 1992; Turner and Turner, 1999) have many skull fragments found mixed with complete skulls. These skulls, however, have evidence of heating which would make the face and head muscle attachments easier to remove. The use of fire has also been identified at the human sample of the Navatu Fijian assemblage (Degusta, 1999), and burning is focused on the head (41%) compared to post-cranial elements (16%). More significantly, the effects of fire are seen more commonly on human remains than on other taxa. In this case, however, Navatu skulls appear highly broken.

The Neolithic site at Fontbrégoua (France) has human skulls that are more complete than non-human skulls (with the exception of bovids). This contrasts with the Native American and Fijian sites. In addition, burning has not been detected on the fossil bones, and this has been interpreted as a case of ritual treatment of skulls and exocannibalism (Villa *et al.*, 1986b). Completeness of human skulls at Gough's cave is quite peculiar due to the fact that they are highly damaged by percussion marks. These contradictory results (strong damage and completeness) may suggest that the skulls were carefully treated to preserve them complete, in contrast to the rest of the skeleton and other animals at the site.

Ribs of both human and large mammals are extensively affected by human induced damage. Cut-marks, percussion marks and peeling are frequent and affect both inner and outer surfaces of the ribs, and some other ribs are also heavily damaged by chop marks. Cut-marks on the inner surfaces have been interpreted as due to evisceration (Diez et al. 1999). Cuts and chop marks on adjacent ribs shows that the damage was inflicted while the rib cage was more or less intact, and the purpose must have been to gain access to the thoracic cavity while at the same time dismembering the ribs. The concentration of marks near the heads of the ribs suggests that the aim was to separate the ribs from the vertebrae (see Fig. 13, above). On the other hand, many of the ribs remained intact, with no further damage, and the ribs from individuals 1 and 2 were discarded within a very small area of the cave. Damage observed on the ribs thus suggests the commonest processes operating on both animal human bodies was dismemberment, filleting and possibly evisceration.

Vertebrae of all taxa recorded at Gough's cave have similar types of damage induced by humans. Cuts appear on similar sides and damage of the transverse or spinous processes are similar. Peeling only occurs on human vertebrae. The human axis and the equid atlas both show cuts on the articulation with the adjacent vertebrae in order to dismember the neck and head. The cuts observed on the front (ventral) of the human axis body are matched by cuts on the hyoid bone and may have been related to detachment of the hyoid. In summary, vertebrae show clear evidences of dismemberment activities, both in humans and non-human skeletons.

Human vertebrae are scarce at Gough's Cave and this is in agreement with Turner's (1983) observations that a characteristic of cannibalism is that vertebrae are usually missing. Turner explains the low representation of vertebrae as a result of having first been crushed on an anvil stone to then the fragments boiled to facilitate oil extraction. He suggests this hypothesis based on ethnographic descriptions of the boiling of animal bones for marrow extraction. Scarcity or absence of vertebrae has been observed among the Prehistoric American Southwest from Arizona (e.g.: Pollaca Wash, Leroux Wash, House of Tragedy, Canyon Butte, Chaco Canyon and others studied by Turner and colleagues 1970–1999) and at the Anasazi pueblo of Mancos (White, 1992), as well as at the French Neolithic of Fontbrégoua (Villa *et al*, 1986a,b), Navatu of Fijian groups (Degusta, 1999), and French Neanderthals (Defleur & White, 1999). Turner & Turner (1995) observed that vertebrae were absent or crushed at the prehistoric and historic Arizona sites. On the other hand, vertebrae are not scarce at the Atapuerca (TD6-*Aurora* Stratum) human assemblage among the early Europeans (Fernández-Jalvo et al. 1999), but here there is no evidence of fire. Villa, *et al* (1985) did not find evidence of fire at Fontbrégoua, and absence of vertebrae was considered as due to humans having moved the discarded bones into 'amas' (discard features). No evidence of burnt bones at Gough's Cave has been observed, but there is similar pattern of breakage and cutting between human and non-human vertebrae.

Four human scapulae, three clavicles and two horse pelves have been recorded at Gough's Cave as the only flat bones. Both scapulae and pelves are intensively damaged by cut-marks and percussion marks. The damage is mainly related to areas of muscle attachments, for example the muscle attachment of *rectus femoris* on the ilium. In the case of scapulae, which all come from humans, they also show peeling as evidence of stripping muscle from the scapula. All cuts found on the scapulae were interpreted by Cook (1986) as the natural effect of trampling processes (notably specimens M54059 and M54056). The cut-marks on these specimens, however, are deeply incised, their positions are often on protected areas of the bone that cannot be reached by sediment grains, and finally most of the cuts are located on areas associated with muscle attachments. They are also concentrated around the glenoid fossa, suggesting disarticulation of the shoulder joint, and they are seen on the muscle attachment areas of *trapezium, triceps, subscapular, teres major* and *teres minor* muscles. In contrast to this, if trampling were the only agent of modification that produced striations, it would be expected that the most salient angles of the scapula, such as the scapular spine or the outer edge of the coracoid process, should be most heavily damaged (Andrews & Cook 1985, Olsen & Shipman 1989). They are not cut, but on the contrary the cut-marks are on the inner angles of these processes. This leads us to the conclusion that the cuts were human-made, although it is certainly true that there are trampling marks as well as cut-marks. On the clavicles, cut-marks are related to muscle attachments, for example the *sternocleidomastoid* on M54054) and the *costoclavicular* ligament, indicating the purpose was dismemberment of the joints.

Most cut-marks on long bones, both on human and on animal, are related to muscle attachment or articular surfaces, indicating dismembering activities. There is also a case of filleting (a right human radius split shaft) with cuts that are not related to muscle attachment. Breakage to open the marrow is more evident on large bones (i.e. femora, humeri, tibiae) than on bones with no marrow content (i.e. radii, ulnae and fibulae). Most long bones, either human or animal bones, show strong percussion marks that occur extensively along the shafts and broken edges, and sometimes percussion marks are seen related to anvil marks. Repeated blows to the shaft are seen on some bones, for example on the human tibia. Adhered flakes, removed flakes, peeling and conchoidal scars related to longitudinal breakage of the bone most probably came about as the result of extracting the marrow content in the bone. Peeling occurs only on human bones (two ulnae, a radius, and a tibia fragment), but it is absent on other animal long bones. Binford (1981) considers scraping and peeling to be linked to the preparation of the bone for subsequent breakage and marrow extraction, since soft tissues might absorb much of the force when the attempt is made to break the bone. On the other hand, Díez *et al.* (1999) considered that periosteum extraction may also be an end in itself, aimed at getting at all of the animal's nutrients. Breakage to open the marrow is more evident on large bones (i.e. femurs, humeri, tibiae) than in no marrow content bones (i.e. radii, ulnae and fibulae). Most long bones, either human or animal bones, and broken edges, and sometimes percussion marks related to anvil marks.

Wrist and ankle bones are present only for large mammals, mostly horse. On these skeletal elements, cut-marks occur most frequently on calcanei (5 out of 8 specimens). Cut-marks on calcanei are mainly located on the calcis, on plantar and dorsal edges, as well as on the articulation between calcaneus and astragalus. Just one calcaneus has a chop mark and it is located on the calcis. Astragali have more cuts on the medial side of the condyle or on the trochlea related to the medial ligament. The other carpal-tarsal bones are damaged on the dorsal sides at the position of the dorsal ligament. In all cases the main purpose appears to be to cut ligaments connecting the lower leg and the metapodials. One central tarsal has an adhered flake on a broken surface on the articular dorsal ridge, probably due to dismemberment.

There are a few human metatarsals, all crushed on the ends but without cut-marks. Lateral metapodials of equids are also crushed on their articular ends as seen on humans. Some human metapodials could have human chewing (Fig. 6). Metapodials are much more abundant in the case of non-human mammals, more than a 50% of them with cut-marks, mainly located on the articulations (Fig. 5A), suggesting dismemberment of the joints. Medial metapodials of horse have a consistent pattern of breakage (Fig. 5B) that has produced great consistency of preservation of the metapodials, and this is probably the result of marrow extraction.

Most phalanges come from equids, with only one of human

Table 4 Surface damage induced by humans and other taphonomic agents at Gough's Cave. The human-induced damage is shown in the top part of the table, and all different types of modification are shown combined in the lower part for comparison with non-human taphonomic modifications

Human induced damage	Cut-marks	Percussion marks	Conchoidal scar	Adhered flakes	Removed flakes	Peeling	Overall human
human	48.9%	26.1%	1.1%	3.4%	3.4%	22.7%	69.3%
equid	37.1%	31.8%	3.8%	1.5%	1.5%	3.0%	73.5%
cervid	50.0%	23.8%	0.0%	4.8%	4.8%	0.0%	57.1%
large-mammal indet	100.0%	100.0%	60.0%	0.0%	0.0%	0.0%	100.0%
Taphonomic damage	Overall human	Trampling	Weathering	Mn oxides	Root-marks	Chewing	
human	69.3%	8.0%	9.1%	2.3%	1.1%	2.3%	
equid	73.5%	3.0%	17.4%	1.5%	0.8%	1.5%	
cervid	57.1%	14.3%	4.8%	21.4%	0.0%	4.8%	
large-mammal indet	100.0%	0.0%	20.0%	20.0%	0.0%	40.0%	

phalanx and four of cervid. Cut-marks and percussion marks appear near the articular surfaces, suggesting dismemberment activities. Terminal phalanges are only known for horse and they have cut-marks at both the palmar and dorsal sides, which is uncommon. Human phalanges are rare and have no cut-marks at cannibalistic sites, like Mancos, Fontbrégoua, Navatu (Turner & Turner, 1990; Villa *et al.* 1986a and 1986b ; White, 1992, Degusta, 1999), and now also Gough's Cave. In contrast to this, there are 16 phalanges from six individuals (5%), some of them cut (19%), at the Atapuerca site (Fernandez et al. 1999). The Neanderthal site of Moula-Guercy (France) has few phalanges too, 9 from 5 individuals, but four of them were cut (44%) and two smashed (22%).

Human-induced damage is the most frequent modification observed on the fossil bones recovered from Gough's Cave (Table 4). Percentages of modifications produced by humans are high, much higher than at other sites where cannibalism has been taphonomically studied (Fig. 25) with the exception of Fontbrégoua (Villa et al. 1986a&b). For instance, nearly half the modifications on fossil bones of both human and non-human species are cut-marks. The high percentage is partly the result of the refitting of bones before the taphonomic analysis was carried on. Weathering, manganese oxide stains, root-marks, chewing do not have a special relevance at the site (Table 5). Chewing mark measurement indicate a small carnivore sized like fox: average tooth mark sizes are1.8mm (N = 23) for surface pits (category a of Andrews & Fernandez-Jalvo 1997); 1.5mm (N = 36) for striations of diaphysis surface (category b); and 2.4mm (N = 25) for punctures on articular ends. These values are similar to those found for a sample of recent sheep bones chewed by foxes (Andrews & Armour-Chelu 1998). Most fossils affected by chewing are complete, and chewing is not related to broken edges (types **d**, **e** or **f**). These traits strongly suggest that the carnivores chewing the bones of the Gough's Cave fossil assemblage could not break the bone but could only chew the surfaces of the bones.

One of the difficulties in analysing the taphonomy of the Gough's Cave assemblage is that much of it comes from old excavations where bone distribution were not recorded. Fortunately, the 1986–87 excavations recorded these data and showed that human and non-human skeletal elements were randomly mixed (Fig. 9). There was also a very high density of finds per square meter, which appears to be proportionally higher than from the old excavations, but it should be noted that the 1986–87 excavations were close to an overhanging wall in the cave, and the higher concentration of remains may be due to preferential preservation in this area protected by the wall. One final point is that no evidence of burning or cooking has been found at Gough's Cave fossil assemblage.

CONCLUSIONS

The single most important conclusion arising out of our analyses is that the butchering techniques observed on human and non-human skeletons at Gough's Cave are similar, apart from differences arising out of differences in body weight. All activities associated with human butchering have been recorded on human and non-human skeletons (Table 5). Peeling, a type of fracture similar to bending a fresh twig between two hands, provides a specific breakage pattern, but it only occurs on human (with the exception of large mammal jaws), and this is related to the lighter body weight and size of humans.

The one major exception to this is the difference in skull completeness. The survival of relatively complete human skulls, despite extensive cut-marks and percussion damage seen on the skulls, indicates special treatment, for in all other cases these processes have resulted in high degrees of breakage, even when the bones thus broken were more robust than thin-walled human skulls. This suggests there may be a ritual element in the treatment of human skulls.

Human and non-human jaws have a high degree of breakage, and the location of cut-marks suggests tongue extraction on both humans and horses. Ribs of both human and large mammals are extensively damaged. Cut-marks and percussion damage suggest dismembering, filleting and evisceration. Vertebrae show clear evidence of dismemberment activities, both in humans and non-human skeletons, although peeling on the vertebrae is restricted to humans.

Table 5 Butchering activities identified at Gough's Cave

		Equid	Cervid	Homo
CRANIAL	Dismembering	•	•	•
	Filleting	•	•	•
	tongue extraction	•		•
	Skinning			•
AXIAL	Dismembering	•	•	•
	Filleting	•		•
	Marrow extraction			
	Evisceration	•	•	•
LIMBS	Dismembering	•	•	•
	Filleting			•
	Marrow extraction	•	•	•
	Periosteum removal	•		•
EXTREMITIES	Dismembering	•	•	•
	Filleting			
	Marrow extraction	•		
	Periosteum removal			

Similarly, peeling only occurs on lightly built long bones (e.g.: human radii and ulnae) with low marrow content. Most large long bones show strong percussion marks that occur extensively along the shafts to extract the marrow content in the bone. Long bones have cut-marks related to dismembering activities (filleting in humans) and periosteum removal shown by the location of scraping marks. Flat bones (human scapulae and horse pelves) are intensively damaged in areas of strong muscle attachment. Human metapodials also show similarities with lateral metapodials of equids, both of which have crushed articular ends.

Taking into account the high similarities in butchering techniques seen on both human and non-human bones, further similar patterns of long bone breakage for marrow extraction, and identical patterns of post-processing discard of human and animal remains in the Gough's Cave sediments, we conclude that this is a case of nutritional cannibalism.

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REFERENCES

Andrews, P. & Cook, J. 1985. Natural modifications to bones in a temperate setting. *Man*, **20**: 675–691.

—— **& Fernández-Jalvo, Y.** 1997. Surface modifications of the Sima de los Huesos fossil humans. *J. Hum. Evol*,. **33**: 191–217.

Arens W. 1979. *The Man Eating Myth: Anthropology and Anthropophagy*. Oxford: Oxford University Press.

Behrensmeyer, A.K. 1978. Taphonomic and ecologic information from bone weathering. *Paleobiology*, **4**: 150–162.

Binford, L.R. 1981. *Bones. Ancient Men and Modern Myths.* New York: Academic Press.

Blumenschine, R.J. 1988. An experimental model of the timing of hominid and carnivore influence on archaeological bone assemblages. *J. Archaeol. Sci.*, **15:** 483–502.

—— **& Selvagio, M.M.** 1988. Percussion marks on bone surfaces as a new diagnostic of hominid behavior. *Nature*, **333**: 763–765.

Bromage, T.G. & Boyde, A. 1984. Microscopic criteria for the determination of directionality of cutmarks on bone. *Am.J. Phys. Anthrop.*, **65**: 359–366

Cook, J. 1986. Marked human bones from Gough's cave, Somerset. *Proc. Univ. Bristol Spelaeol. Soc.*, **17**: 275–285.

Charles, R. 1998. Cresswell, Cheddar and Paviland. *Current Archaeology*, **160**: 131–135.

Churchill, S. 2000. The Creswellian (Pleistocene) human axial skeletal remains from Gough's Cave (Somerset, England). *Bull. Nat. Hist. Mus. Lond. (Geol.)*, **56:** 141–154.

—— 2001. The Creswellian (Pleistocene) human upper limb remains from Gough's Cave (Somerset, England). *Bull. Nat. Hist. Mus. Lond. (Geol.)*, **57:** 7–24.

Currant, A.P.; Jacobi, R.M. & Stringer, C. 1989. Excavations at Gough's Cave, Somerset 1986–7. *Antiquity*, **63**: 131–136

Defleur, A., White, T., Valensi, P., Slimak, L. & Crégut-Bonnoure, E. 1999. Neanderthal cannibalism at Moula-Guercy, Ardèche, France. *Science*, **286**: 128–131.

Degusta, D. 1999. Fijian Cannibalism: osteological evidence from Navatu. *Am. J. Phys. Anthrop*, **110**: 215–241.

Díez, J.C., Fernández-Jalvo, Y., Rosell, J. & Cáceres I. 1999. The site formation (Aurora Stratum, Gran Dolina, Sierra de Atapuerca, Burgos, Spain). *J. Hum. Evol.*, **37**: 623–652.

Fernández-Jalvo, Y., Díez, J.C., Cáceres, I. & Rosell, J. 1999. Human cannibalism in the early Pleistocene of Southern Europe (Sierra de Atapuerca, Burgos, Spain). *J. Hum. Evol.*, **37**: 591–622.

Flinn, L.; Turner, C.G.II & Brew, A. 1976. Additional evidence for cannibalism in the Southwest: the case of LA 4528. *Am. Antiquity*, **41**: 308–318.

Olsen, S. & Shipman, P. 1988. Surface modification on bone: trampling versus butchery. *J. Archaeol. Sci.*, **15**, 535–553.

Shipman P. & Rose, J. 1983. Early hominid hunting, butchering and carcass-processing behaviours: approaches to the fossil record. *J. Anthrop. Archaeol.*, **2**, 57–98.

Stringer, C. 2000. The Gough's Cave human fossils: an introduction. *Bull. Nat. Hist. Mus. Lond. (Geol.)*, **56**: 135–139.

Taylor, P.D. 1986. Scanning electron microscopy of uncoated fossils. *Paleontology*, **29**, 689–690.

Trinkaus, E. 2000. The Creswellian (Pleistocene) human lower limb remains from Gough's Cave (Somerset, England). 2000 *Bull. Nat. Hist. Mus. Lond. (Geol.)*, **56:** 155–161.

Turner, C.G. II. 1983. Taphonomic reconstruction of human violence and cannibalism based on mass burials in the American Southwest. In G. LeMoine & S. MacEachern (editors) *Carnivores, Human Scavengers and Predators: a Question of Bone Technology.* Proceedings of the XV Annual Conference of The Archaeological Association of the University of Calgary.

—— 1988. Another prehistoric Southwest mass human burial suggesting violence and cannibalism: Marshview Hamlet, Colorado. In: (G.T.Gross and A.E. Kane, compilers) *Dolores Archaeological Program: Aceramic and Late Occupations at Dolores*, 81–83 Bureau of Reclamation. Denver, Colorado.

—— 1993. Cannibalism in Chaco Canyon: the channel pit excavated in 1926 at Small House Ruin by Frank H.H. Roberts, Jr. *Am.J.Phys. Anthrop.*, **91**, 421–439.

—— **& Morris, N.T.** 1970. A massacre at Hopi. *Am. Antiquity*, **35**, 320–331.

—— **& Turner, J. A.** 1990. Perimortem damage to human skeletal remains from Wupatki National Monument, northern Arizona. *Kiva*, **55**, 187–212.

—— & —— 1992. The first claim for cannibalism in the Southwest: Walter Hough's 1901 discovery at Canyon Butte Ruin 3, Northeastern Arizona. *Am. Antiquity*, **57** (4), 661–682

—— & —— 1995. Cannibalism in the prehistoric American Southwest: occurrence, taphonomy, explanation and suggestions for standardized world definition. *Anthropol.Sci.*, **103**, 1–22.

—— & —— 1999. *Man Corn: Cannibalism and Violence in the Prehistoric American Southwest.* University of Utah Press. Salt Lake City.

Villa, P., Bouville, C., Courtin, J., Helmer, D., Mahieu, E., Shipman, P., Belluomini, G. & Branca, M. 1986a. Cannibalism in the Neolithic. *Science*, **233**, 431–437.

——**, Courtin, J., Helmer, D., Shipman, P. Bouville, C. & Mahieu, E.** 1986b. Un cas de cannibalisme au Néolithique. *Gallia Préhistoire*, **29**, 143–171.

—— **& Mahieu E.** 1991. Breakage patterns of human long bones. *J.hum.Evol.*, **21**, 27–48.

White T.D. 1992. *Prehistoric Cannibalism at Mancos 5MTUMR-2346* Princeton: Univ. Press, Princeton, NJ.